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15 September 1982

USSR REPORT  
ELECTRONICS AND ELECTRICAL ENGINEERING

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UDC 621.391

SYNTHESIS OF CORRELATIONAL-EXTREMAL SYSTEMS WITH KALMAN FILTRATION

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 25, No 3, Mar 82 (manuscript received 2 Sep 80, after revision 4 May 81) pp 53-57

BAKLITSKIY, V. K.

[Abstract] A two-dimensional correlational-extremal navigation system is synthesized according to the algorithm of optimum estimation of multistep stochastic processes, for processing space-time signals by the nonlinear Kalman filtration method or its linear modification. The result should not depend on the method used, although different solutions are known to be obtained for time processing with a quasi-optimum nonlinear Kalman filter and with a nonlinear Gaussian-approximation filter, respectively. Figures 1; references 8: Russian.  
[258-2415]

UDC 621.391:621.396.96

OPTIMIZATION OF INTERPERIOD SIGNAL PROCESSING WITH CLUTTER SUPPRESSION IN INCOHERENT RADAR

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 26, No 12, Dec 81 (manuscript received 8 Jul 80) pp 2600-2606

KISELEV, A. Z.

[Abstract] The present work solves the problem of optimization of the parameters of a device for suppression of the reflections of an incoherent radar on the basis of energy quality criteria. Interperiod weight processing is considered during which the correlation functions (matrices) of the weight of the useful and interfering signals are determined. During this the processing device possesses a high effectiveness in finding targets and has a substantially smaller range of values of the weight coefficient than,

for example, a device for multiple "through-period" deduction. The following are considered in the work: 1) Processing algorithm; 2) Correlation matrices of problem; and 3) Quantitative results and evaluation of precision of formulas obtained. It is concluded that use of the method considered makes it possible to optimize the linear interperiod processing of signals in incoherent radars and to improve the observability of moving targets on a background of clutter in such radars. Tables 2; references 6: 5 Russian, 1 nonRussian in translation.

[152-6415]

UDC 621.396.67.01

#### JOINT SPATIAL RESOLUTION WITH RESPECT TO DISTANCE AND DIRECTION IN COHERENT RADAR SYSTEMS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 26, No 12, Dec 81  
(manuscript received 13 Aug 80) pp 2607-2613

KREMER, I. Ya. and PETROV, V. M.

[Abstract] The present work analyzes the effect of the elements of randomly dispersed antenna systems on the possibility of a joint spatial resolution with respect to both distance and direction in coherent radar systems. As shown in 1975 and 1977 works of which I. Ya. Kremer (see above) is the principal author, it is possible to evaluate the possibility of space resolution, as well as the effectiveness of spatial selections for separation of useful signals from interference produced by external sources, with the aid of the autocorrelation functions [ACF] of a space-time signal with respect to distance and direction. A coherent radar system is considered, the antenna system of which is formed of the initial nondispersed array by removal of the majority of elements of the ladder with respect to a random law, during which the separate elements have directional patterns uniform in the operating sector of angles. It is found possible to determine the location of the elements of a randomly open antenna system which assures with a minimum number of elements the least possible level of lateral lobes with ACF with respect to direction and distance, as well as the optimum spatial resolving ability with respect to direction and distance in the case of a given level of lateral lobes. Figures 4; tables 1; references 6:

5 Russian, 1 Western.

[152-6415]

## TWO EQUATIONS OF UNDERGROUND RADAR

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 3, Mar 82  
(manuscript received 13 Nov 78, after correction 22 Jun 81) pp 431-437

LUCHININOV, V. S.

[Abstract] Bistatic radar for underground search is considered, namely for locating a concentrated target or a distributed one (reflecting surface) in a multilayer medium with nonplane quasi-isotropic rough boundaries such as the earth crust and ice caps. A completely polarized narrow-band signal propagates with reflections and refractions, the wavelength of its lowest-frequency component being much smaller than the distances from radar antenna and from target to the boundaries of the nearest layers, also much smaller than the characteristic dimensions of these layers. The layers are assumed to be stationary, homogeneous and weakly absorbing. The radar equation for a concentrated target is reduced to that for a point target in free space and then extended to one for a reflecting boundary surface. Figures 2; references 13: 9 Russian, 4 Western (one in translation).  
[206-2415]

UDC 621.391

DISCRETE DATA PROCESSING DURING SIMULTANEOUS MEASUREMENT OF SIGNAL FREQUENCY AND ITS DERIVATIVE

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 11, Nov 81 (manuscript received 7 Jul 80) pp 40-45

PISKORZH, V. V. and CHUMACHENKO, A. A.

[Abstract] An optimum algorithm of processing the mixture of signal frequency and its derivative in radar measurements for estimating both parameters is shown which uses discrete periodic Kotel'nikov readings of a continuous signal by a digital measuring instrument as well as the flux of its zero crossovers. The complex correlation integral is represented as a two-dimensional Kotel'nikov series, for which the interval of finiteness of its Fourier transform is determined with the aid of the convolution theorem. Interpolation within this interval is then performed by the method of fast Fourier transformation. The algorithm includes calculation of the correction vector, namely dividing the vector of first derivatives of the squared modulus of the correlation ontegral by the matrix of its second derivatives at the rough estimate of both parameters. Figures 1; references 8: 6 Russian, 2 Western (1 in translation).  
[162-2415]

UDC 621.391.2

DEPENDENCE OF PERFORMANCE OF DIFFERENCE-TYPE RANGE FINDER ON CROSS-CORRELATION OF SIGNALS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 25, No 4, Apr 82 (manuscript received 21 Oct 81) pp 98-100

DUGIN, V. V., SKRIPCHENKO, S. V. and TETEL'BAUM, I. S.

[Abstract] Locating the rms error of a range finder consisting of three receivers staggered in a plane depends on the difference  $\tau_{12}$ ,  $\tau_{23}$  between

signal travel times from object to receivers. These differences can be determined from the shift of peaks, relative to zero time delay, of the respective signal cross-correlation functions. This cross-correlation function is usually estimated through averaging of the readings of input signals over a finite time period, assuming the signals to be ergodic. The cross-correlation function of errors is calculated analogously. The accuracy of determining the coordinates of an object by means of such a range finder can now be estimated, assuming a sufficiently high signal-to-noise ratio of the order of 10, as demonstrated in the case of zero interference correlation between receivers and a frequency-dependent signal attenuation. Figures 2; references 2: Russian.  
[262-2415]

UDC 621.392.268

#### CORRELATION ANALYSIS OF RANDOM SIGNALS WITH VARYING DELAY

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 4, Apr 82 pp 54-56

DINKEVICH, V. V. and KUZ'MIN, Yu. I.

[Abstract] The crosscorrelation function of random signals from a source moving at unknown velocity from one receiver to another is determined, taking into account the Doppler effect. A method is proposed for lengthening the estimation averaging time in the case of a constant rate of change of the time delay, i.e., constant Doppler shift between received signals. It involves increasing the discretization frequency by a factor  $k$  which will ensure full compensation and then restoring the continuous signal. A device implementing this method is synthesized for operation in real time, not with a larger number of analog devices tuned to narrower velocity intervals but with compensation of the Doppler shifts through processing of the results of repetitive correlation analyses with the averaging time limited within each cycle. Figures 2; references 5: 4 Russian, 1 Western.  
[259-2415]

UDC 621.396.029.33:551.51

#### RECEIVER FOR TURBULENT ATMOSPHERIC CHANNEL

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 4, Apr 82 pp 33-35

SEBKO, S. Ye. and KLIMASHIN, V. P.

[Abstract] An optical receiver is described in which the effect of turbulent atmosphere in the channel on the space-time coherence of propagating radiation has been minimized. Effect of small-scale turbulence is eliminated

by a filter of space frequencies and the effect of large-scale turbulence is eliminated by automatic stabilization of the space spectrum relative to this filter. The homodyne equipment consists of a signal detector, a low-pass filter, a stabilized variable-gain differential amplifier, two photodiodes with limiting slits, a mixer, a pair of collimator lenses, a laser, three divider plates, a modulator, two short-circuiting mirrors, a condenser lens, the photoreceivers, an amplifier-discriminator, receiver optics, a d.c. power supply, a filter of space frequencies, a coordinate-sensitive photoreceiver, a power amplifier, an electronic device for extracting the angular mismatch signal, and an angle and phase stabilizer drive. The receiver was tested with a He-Ne laser as light source, a Fabry-Perot interferometer as mode selector, a two-lens objective (110 mm diameter, 1120 mm focal length) as receiver optics, and perforated blackened brass foil as filter of space frequencies. Maximum sensitivity of  $2 \cdot 10^{-4} \lambda$  over a distance of 230 m was attained in favorable city weather at wind velocities up to 2 m/s. A sensitivity of  $10^{-6} \lambda$  has been found to be unattainable. Figures 1; references 11: 10 Russian, 1 Western.  
[259-2415]

UDC 621.396.61:621.396.2

# ENERGY SPECTRUM OF PACKETS OF COHERENT SIGNALS IN RADAR SYSTEMS WITH FLUCTUATING PARAMETERS

Moscow RADIOTEKHNIKA in Russian Vol 37, No 4, Apr 82  
(manuscript received 14 Apr 81) pp 41-44

DRAPIY, V. A.

[Abstract] Power amplifiers in radar systems are considered which have been designed for optimal, with respect to additive noise, detection of packets of periodic sequences of coherent radio pulses under conditions of modulating interference caused by supply voltage fluctuations. The effect of dependently fluctuating amplitude and phase characteristics of the receiver-transmitter channel on the energy spectrum of such sequences of complex signals is determined, taking into account resulting intrapulse phase or frequency modulation. Disregarded are, however, the effects of additive internal system noise and external interference on the output signal form the optimal filter in the receiver. This signal is treated as a nonstationary random process. Its energy spectrum and that of the interference component are determined from the amplitude spectrum of the autocorrelation function of the radio pulse and the Fourier expansion of the modulation caused by interference. A relation is established on this basis between signal and interference components of the energy spectrum. References 10: 8 Russian, 2 Western in translation.  
[260-2415]

# ACCURACY OF MEASURING COORDINATES OF COMPLEX TARGET IN FRESNEL REGION OF LINEAR ANTENNA

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 3, Mar 82  
(manuscript received 10 Jul 80) pp 471-476

KREMER, I. Ya. and POTAPOV, N. A.

[Abstract] An array of bright spots within one element of space resolution is regarded as a complex text. The problem considered in the present report is the accuracy of measuring the coordinates of such a target so large as to be located in both the Fresnel and Fraunhofer regions of the linear receiver antenna. The signal-to-noise ratio is assumed to be sufficiently high so that errors caused by additive noise become negligible while fluctuations of signal wave front and signal arrival time remain the sole source of measurement error. These fluctuations are caused by interference of signals from separate but indiscernible bright spots on the solid target. The analysis is based on relations for the Fresnel region. The probability density of errors obtained by simulation on a digital computer differs from that according to the truncated Student's distribution, but the approximate expression derived for the dependence of the standard deviation of error on the ratio of space resolution to target dimension remains applicable over a wide range of this ratio, up to 0.8 with the error not exceeding 15%. Figures 4; references: 8 Russian.  
[206-2415]

# FASTER ADAPTIVE OPTIMIZATION PROCEDURES FOR SWITCHING ANTENNA ARRAYS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 3, Mar 82  
(manuscript received 11 Jul 80) pp 463-470

ABRAMOVICH, Yu. I., AYZIN, F. L., DANILOV, B. G. and KOGAN, B. L.

[Abstract] Adaptive optimization is sought for switching antenna arrays on the basis of simplified mathematical models and by correspondingly faster procedures. Analytical estimates of adaptation efficiency are obtained for an arbitrary plane phase array with a uniform distribution of quasi-random phases, and the dependence of this efficiency on the total number of samples is established. Next "truncated" adaptation procedures are considered, with reduction of the interference output power by some given factor in the last step serving as criterion for terminating the optimization process. The optimum threshold of the target function to be minimized here not only varies with the number of interference sources but can also change during optimization steps. Calculations for the case of four interference sources

but can also change during optimization steps. Calculations for the case of four interference sources indicate that a 15-17 dB suppression is attainable with one order of magnitude fewer measurements than are necessary in the method of maximum element. There are additional losses involved, but the tradeoff is entirely acceptable. Figures 3; references 5: 4 Russian, 1 English in translation.  
[206-2415]

UDC 621.396.96

#### DESIGN OF NONRECURSIVE ADAPTIVE COMPENSATOR OF TWO-COMPONENT CLUTTER

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 24, No 11, Nov 81 (manuscript received 7 Jul 80, after revision 2 Feb 81)  
pp 60-63

BAKULEV, P. A. and KOVAN, S. Ye.

[Abstract] A compensator of two independent clutter components is designed for a coherent-pulse radar by cascading two interperiod subtractors with the resultant transfer function  $K(z^{-1}) = (1 + a_1 z^{-1})(1 + a_2 z^{-1}) = 1 + b_1 z^{-1} + b_2 z^{-2}$  ( $z^{-1}$  Z-transformation operator,  $a_1, a_2$  multiplication factors equal to respective interference correlation coefficients,  $b_1 = a_1 + a_2$ ,  $b_2 = a_1 a_2$ ). The compensator parameters for minimum residual output interference suppression, are calculated and an algorithm of estimating the multiplication factors is constructed. Disregarding the dependence on the moduli of the correlation coefficients for the two clutter components results in some loss of suppression, which however rapidly decreases as the difference between Doppler phase shifts increases. Figures 3; references 2: Russian.  
[162-2415]

UDC 621.396.96:621.391.26

#### SYNTHESIS OF AUTOCOMPENSATORS OF DOPPLER CLUTTER RATE

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 24, No 11, Nov 81 (manuscript received 6 Feb 80, after revision 12 Sep 80)  
pp 54-59

POPOV, D. I.

[Abstract] The problem of compensating the Doppler rate of clutter caused by the relative motion of target and radar antenna, and subsequent extraction of signals from "standing" interference, is solved by synthesis of an optimum autocompensator-discriminator structure. Interference caused by

reflections by large objects is regarded as a narrow-band random Gaussian process in the two-dimensional azimuth-distance strobe, additively mixing with internal noise. The equation of the optimum discriminator is written first for a tracking instrument and then for a nontracking one, with the likelihood function in this equation based on interference which has no correlation between resolution elements and is uniform with respect to Doppler rate. The algorithm is either based on a priori known correlation characteristics of interference or it must be an adaptive one. The estimation algorithm ensures minimum duration of the transient process in a tracking instrument and maximally likely estimates, always asymptotically efficient and normal sound ones, in a nontracking instrument. The accuracy of a digital tracking instrument containing an ideal integrator as smoothing filter and operating by this algorithm is found to be satisfactory. Digital autocompensators of Doppler clutter rate, designed on this basis with the proper choice of parameters, are very suitable for detection by any method of signals from moving targets. Figures 2; references 7: Russian. [162-2415]

UDC 621.396.677.833.1

#### POSSIBILITY OF WIDE-ANGLE SCANNING IN HYBRID REFLECTOR ANTENNAS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 26, No 12, Dec 81  
(manuscript received 9 Jun 80) pp 2500-2510

ALIMOVA, L. I., KINBER, B. Ye., KLASSEN, V. I. and SHISHLOV, A. V.

[Abstract] The paper is concerned with the possibility of creating irradiating units for deflection of a ray at large angles of tens and hundreds of times the width of the main lobe. This is without substantial change of the front-to-rear factor [RFR], both in situations where it is necessary to create a discrete quantity of rays deflected at a fixed angle from the axis of the reflector, and for the case of the scanning ray in the final sector of angles. Creation of a ray strongly deflected from the axis of the reflector requires use of irradiating units. The magnitude of these units can be as large as  $1/3$  to  $1/2$  the dimensions of the reflector. The name "hybrid reflector antennas" is given to reflector antennas of such a type, in which the width of the ray and the FRF are determined by the dimensions of the reflector, and the deflections of the diagram or scanning are assured with the aid of multielement radiating units. The problems of determining the geometry of the multielement irradiating unit of a hybrid antenna, where it must be located, the frequency characteristic of excitation, and the limiting potentialities of deflection of the ray are considered in the present work from the position of geometrical optics and the geometrical theory of diffraction. The following items are discussed in the work: 1) The ray structure of the field which is formed by an irradiating units; and 2) Excitation law of irradiation unit and role of diffraction effects. The results of numerical experiments are presented. The following graphs are among those presented:

1) Relationship of dimensions of reflector and irradiating unit in hybrid antenna; 2) Excitation law of irradiating unit; 3) Role of diffraction effects with use of geometric optics for calculation of reflection antenna. Figures 6; references 9: 7 Russian, 2 Western.  
[152-6415]

UDC 621.398.8.089.6

#### ERROR OF ANTENNA CALIBRATION BY RADIOMETRIC METHOD

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 4, Apr 82 pp 56-58

ARSAYEV, I. Ye.

[Abstract] A problem in calibration of antennas by the radiometric method is the fact that the error of absolute-gain measurement depends on the distance from the calibrating disk, on the angular dimensions of the latter, and on the antenna parameters. Here this situation is analyzed in the Rayleigh-Jeans approximation, disregarding diffraction at the disk periphery as well as interference between disk and antenna. The "black" disk is uniformly heated from temperature  $T_1$  to temperature  $T_2$ , while the power increment at the radiometer output is read on a temperature scale. Relations strictly valid for the far field of the antenna are adjusted for the Fresnel region. The error term of the asymptotic expansion for an axisymmetric two-mirror parabolic antenna has been evaluated numerically on the basis of the Kirchhoff approximation of the main term representing the radiation pattern in the far field and a quadratic approximation of the field distribution in the aperture of the large mirror. Large disks are used for measuring the radiation power outside the major lobe or within a given solid angle with an insufficiently sensitive radiometer receiver, because the error of gain readings decreases with increasing disk size or the distance can be increased without exceeding a given permissible error. The energy redistribution within the radiation pattern of a parabolic mirror antenna after optimum focusing on a finite distance is also calculated on the basis of these approximations. Figures 3; references 7: 6 Russian, 1 Western.  
[259-2415]

UDC 535.375:681.7.068.4

EFFECT OF SUPPORTING QUARTZ TUBES ON MAGNITUDE OF LIGHT INTENSITY ATTENUATION IN OPTICAL FIBERS

Moscow RADIOTEKHNIKA in Russian Vol 37, No 4, Apr 82  
(manuscript received 9 Nov 81) pp 25-30

GRIGOR'YANTS, V. V., ZIGUNSKAYA, A. V., IVANOV, G. A., KORENEVA, N. A.,  
CHAMOROVSKIY, Yu. K. and SHEMET, V. V.

[Abstract] Optical fibers are produced by the chemical paraffin process, with glassy waveguide layers of doped quartz glass deposited on the inside surface of the supporting quartz tube by concurrent oxidation of silicon tetrachloride and halogenides of alloying elements ( $\text{BBr}_3$ ,  $\text{POCl}_3$ ,  $\text{GeCl}_4$ ). Attenuation of the light intensity along such a fiber can be described by the loss equation  $\alpha = A\lambda^{-4} + B + C(\lambda) + D(\lambda) + \dots$  ( $\lambda$  - wavelength of light,  $A$  - loss caused by Rayleigh scattering dependent on core material,  $B$  - loss caused by scattering by structural defects,  $C$  - loss caused by absorption by microimpurities of transition metals in fiber core,  $D$  - loss caused by absorption by hydroxyl ions). On the basis of nameplate and test data on Soviet and Bulgarian products, optical fibers with quartz tubes of various grades were evaluated with regard to these loss components and their spectral characteristics. The results reveal an appreciable dependence of attenuation on the quality, regardless of heat treatment, of the quartz tube. Direct deposition of waveguide layers on the tube surface in an  $\text{HCl}$  stream does not ensure low losses, but an about 400 micrometer thick borosilicate interlayer provides an effective shield for these layers against contamination from the supporting tube. Some attenuation was also found to be caused by "gray" losses associated with deformation of the core-sheath interface, variances here being principally caused by differences in the quality of quartz tubes used in any given technological process. The authors thank M. Ye. Zhabotinskiy for formulating the problem and discussing the results. Figures 4; tables 2; references 14: 5 Russian, 9 Western.  
[260-2415]

## TECHNOLOGY OF FIELD INSTALLATION OF OPTICAL CABLES

Moscow RADIOTEKHNIKA in Russian Vol 37, No 4, Apr 82  
(manuscript received 12 Oct 81) pp 78-80

KLEPARSKAYA, T. V., PLOSHAY, L. L., SMIRNOV, V. I., FILIMONOV, V. P. and  
CHERTOV, V. G.

[Abstract] Both solid and split connectors are used for field installation of optical cables: solid ones for repair and service restoration, split ones for experimental and pilot operation. The basic device is a solid connector consisting essentially of capillary tubes into which corresponding ends of fiber strands are inserted for splicing and which in turn are fitted into and bonded to metal end caps. Split connectors are essentially modified versions. The installation procedure involves matching and aligning the fibers to be spliced, measurement of losses by the telephone method, pulling a sleeve for mechanical protection with adequate sealing against moisture and corrosion. Connectors of both types have been designed, bonding and sealing materials have been selected, and the installation procedure has been refined to ensure minimum variance of geometrical parameters and minimum attenuation (losses) in the joints. Figures 7; references 4: 1 Russian, 3 Western (2 in translation).

[260-2415]

## FIBER OPTICS FOR DATA TRANSMISSION LINES IN AUTOMATIC CONTROL SYSTEMS FOR CHARGED-PARTICLE ACCELERATORS

Moscow RADIOTEKHNIKA in Russian Vol 37, No 4, Apr 82  
(manuscript received 12 Oct 81) pp 30-35

VANICHKIN, P. G., VATUTIN, V. M., VAGIN, A. I., KONTOROV, M. D., MONIN, Yu. I. and NIKOLAYEV, A. A.

[Abstract] Fiber optics or fiber optics in combination with an open optical line (vacuum, air, inert gas) are considered for transmission of digital and analog data in automatic control systems for charged-particle accelerators, from sender (data gathering and converting module, power amplifier, radiator, optical matching device) to receiver (optical matching device, photoreceiver, amplifier, data processing and distributing module). While fiber optics are more economical and have better optical performance characteristics, especially single-fiber gradiental (or with ladder profile or refractive index) conductors, open lines are structurally simpler and offer complete galvanic decoupling. Four optical lines have been designed and built for all levels of automatic control of accelerators. They include two fiber optical lines,

one for "computer - computer/plant interface - computer" communication and one with microprocessor-mode of data acquisition and transmission at the low-voltage level, an open optical line for local computer-computer and inter-subsystem communication within the automatic control system, and a hybrid optical line for data transmission from a high-voltage source. Figures 9; tables 2; references 10: 9 Russian, 1 Western.  
[260-2415]

UDC 621.397.2.037.372:006

#### INTERNATIONAL STANDARD FOR DIGITAL CODING

Moscow TEKHNICA KINO I TELEVIDENIYA in Russian No 3, Mar 82 pp 49-54

KRIVOSHEYEV, M. I., NIKANOROV, S. I. and KHLEBORODOV, V. A.,  
State Scientific Research Institute of Radio; All-Union Scientific Research  
Institute of Television and Radio Broadcasting

[Abstract] The AA/11 International Standard for digital coding of video signals in studios, according to the first recommendations of CCIR adopted in February 1982, defines 4:2:2 coding parameters for 525-line and 625-line systems, provides for separate or compound coding of brightness and color signals to replace incompatible analog coding systems, specifies discretization frequencies and sampling rates, as well as the nominal levels of video signals in white, black, three primary colors and three complementary colors. Preliminary specifications are already available for 4:4:4 coding standards. Tables 3; references 11: 4 Russian, 7 Western.  
[204-2415]

UDC 621.397.61:681.772.7.049.77

#### EXPERIMENTAL TELEVISION CAMERA WITH CHARGE-COUPLED DEVICES

Moscow TEKHNICA KINO I TELEVIDENIYA in Russian No 3, Mar 82 pp 54-56

VOLODIN, V. A., LOBANOV, V. D. and UVAROV, N. Ye.

[Abstract] Television cameras are being developed in the USSR and abroad which use photosensitive charge-coupled devices rather than conventional cathode-ray tubes as photoelectric converters, the main advantage of this being the possibility of miniaturization and eventually microminiaturization through use of special-purpose integrated microcircuits. A typical example is the Fairchild MV-301 camera developed in the United States. For mass production of industrial-TV cameras 1200 TsM1 in the Soviet Union, there is already available an experimental prototype miniature camera containing two single-chip integrated circuits with CMOS transistors, one

generating logic signals for control and one converting them to signals directly applied to the phase electrodes. Their period of the horizontal sweep can be 64 or 128 microsecond in the case of interlacing, with 315 lines per frame. The camera contains a matrix of 232 x 288 resolving elements for approximately 150 horizontal and 200 vertical lines. The camera operates from a +15 V supply, drawing a power of 1 W. Figures 2; references 5: 2 Russian, 3 Western (1 in translation).  
[204-2415]

UDC 621.397.62

#### FILTER ON SURFACE-ACOUSTIC-WAVE STRUCTURE FOR VIDEO CHANNEL OF TELEVISION RECEIVER

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 11, Nov 81 (manuscript received 27 Jun 80, after revision 15 Jan 81) pp 81-83

DASHENKOV, V. M., SINITSYA, V. N. and BIRGER, A. Ye.

[Abstract] A filter with the required asymmetric frequency characteristic for the intermediate-frequency video amplifier in a television receiver is described which consists of two interdigital SAW transducers. The apodized transducer has an S-structure consisting of an even number (192) of bars symmetrically spaced on both sides of a center gap, with a space period corresponding to a  $\pi$ -type frequency stagger of 69.7 MHz. The nonapodized transducer has a C-structure containing an odd number (15) of bars with the axis of symmetry through the center bar, with a space period corresponding to a  $\pi$ -type frequency stagger of 34.7 MHz. The bars in the two transducers are respectively 12.3 and 24.7  $\mu\text{m}$  wide. Parasitic coupling between the transducers by means of volume acoustic waves weakens signal suppression outside the passband. This difficulty has been overcome by slanting the  $\text{LiNbO}_3$  acoustic waveguide on which both transducers are mounted at  $8 \pm 1^\circ$  to the active surface and filling two 0.4 mm wide and 0.8-0.9 mm deep notches in it with sound absorbing material. The transducers have input impedances of 690 and 765 ohm/pF and output impedances of 17.5 and 7.5 ohm/pF, respectively. The filter fits into the hybrid integrated microcircuit of the i-f video amplifier. Figures 1; references 5: 3 Russian, 2 Western.  
[162-2415]

## NEW TELEVISION RELAYS

Moscow VESTNIK SVYAZI in Russian No 4, Apr 82 pp 27-28

POPOVICH, V. P., chief engineer, Central Administration of Space and Radio Communication, USSR Ministry of Communications

[Abstract] Development of multiprogram television broadcasting of higher quality combined with reduction of operating costs and personnel requires better utilization of frequency channels with more efficient equipment. One item contributing to this trend is a new automatic transistor-type television relay with a power rating of 10 W built in Bulgaria according to All-Union State Standards and scheduled for series production in 1982. It consists of a 100 mW transceiver with filter, i-f (38 and 31.5 MHz), mixer, amplifier, detector, and decoupling stages, a 1 W power amplifier (KT907 transistor) mounted integrally with the transceiver and a 10 W power amplifier (KT909 transistor) mounted separately. The relay has been designed for reception channels II, III and transmission channel III, for either continuous unattended operation or by remote control, from a  $220 \pm 10\%$ ,  $-30\%$ , 50 Hz line at ambient temperatures from  $+5$  to  $+40^\circ\text{C}$ , with a quartz oscillator stable within 22 Hz, an intermodulation distortion not exceeding  $-51$  dB and a combination-frequency interference level not exceeding  $-56$  dB. The package weighs 150 kg. The transmitter antenna consists of four ATR-2-III panels, the receiver antenna consists of eight waveguide segments. The relay is grounded together with the antenna bracket, is decoupled from external circuits through a 1:1 isolation transformer, and is protected by a lightning arrester. Two units have been in pilot operations since 1979, one in the Zakarpatskaya Oblast and one in the Krymskaya Oblast of the Ukrainian SSR. Figures 5.  
[266-2415]

## MODERNIZATION OF 'YAKOR'' RADIO-TELEVISION TRANSMITTER STATION

Moscow VESTNIK SVYAZI in Russian No 4, Apr 82 pp 32-33

FRIDMAN, E. M., chief, Central Laboratory of Public Soviet Radio Television Station imeni October Semicentennial, ORLOV, V. V., senior specialist, Central Laboratory, and FILIPPOV, V. M., senior engineer, Regional Administration of Radio Television at UkSSR Ministry of Communications

[Abstract] By 1981 Improvements in the "Yakor'" [Anchor] radio-television transmitter station resulted in two more modern versions of video channel design. The basic first version allows for standby capacity, with one transmitter operating at nominal power level and another transmitter standing idle in reserve. There is no need for automatic phasing here, inasmuch as phasing occurs at output frequencies and no buildup of phase mismatch takes place in subassemblies to be put together. Most failures have, moreover, been found to occur when equipment is switched on and during the first

few minutes of operation. The advantages of the second version taking all this into account are higher reliability with conventional constant-load sliding (200%) standby and with duplication logic, half as many components in the control and regulation system, no need for stringent phasing, matching, compensation, and complete decoupling of terminal stages. The performance of the updated "Yakor'" transmitter station is characterized by high efficiency (66%), better economy (3000 kW.h annually), longer stability of video channel parameters, and higher peak power (5.0 kW) with a GU-34B tube in the next to last stage and a GU-35 tube in the output stage (power gain  $K_p = 15$ ) replacing GU-40B tubes. Although the basic circuitry of the new video channel is the same as before, the components have naturally different dimensions and are packaged better so as to be more accessible for maintenance and repair. Figures 6; tables 1.  
[266-2415]

UDC 656.25.071.84:656.25:621.315.23

#### ENSURING OPERATIONAL RELIABILITY OF CABLE COMMUNICATION LINES

Moscow AVTOMATIKA, TELEMEXHANIKA I SVYAZ' in Russian Now3, Mar 82 pp 19-22

SHABOTENKO, V. I., chief of signalization and communication service for South-West route, DOMASHNIY, V. A., deputy chief of service, MALKIMAN, V. M., senior engineer, communications laboratory for South-West route, and KUKSIN, A. N., senior scientist, Institute of Chemistry of High-Molecular Compounds, UkSSR Academy of Sciences

[Abstract] A study of cable failures in the signalization and communication system for the South-West route has revealed that they occur mainly as a result of oxidation at the contact between different metals inside the connecting sleeves, especially at branch points. A subsequent study was made in order to determine the feasibility of moving a gas-tight sleeve closer to the end of the branching cable, reinstalling it 3-5 m from the pothead, and thus improving the reliability. The cable splicing process, namely restoration of continuity in the protective insulating sheath, was modified at the same time. Three methods of joining cut ends were tried: bonding with "Styk-FP" polyurethane adhesive, wrapping with polyurethane-impregnated glass tape, and covering with a tube of thermosetting material. The last method yielded the best results. With preventive insulation-to-ground measurements and fault detection, the vulnerable spots could be located and adequately protected. The result is a more reliable and economical pressurized-cable railroad communication system. Figures 7.  
[251-2415]

# CONCENTRATED INTERFERENCE SUPPRESSION ALONG CABLE SEGMENT BETWEEN TWO ATTENDED REPEATER STATIONS

Moscow AVTOMATIKA, TELEMEXHANIKA I SVYAZ' in Russian No 3, Mar 82 pp 3-7

VINOGRADOV, V. A., docent, Leningrad Institute of Railroad Transportation Engineers, KUSTYSHEV, S. Ye., graduate student, DOMASHNIY, V. A., deputy chief of signalization and communication service for the South-West route, KNIZHNIK, V. I., chief of communications laboratory, and MALKIMAN, V. M., senior engineer

[Abstract] Concentrated interference suppression is more effective than conventional balancing by transposition and use of counter coupling circuits, and it also extends beyond a repeater station over a cable segment between two such stations. A counter coupling device is installed in the receiver station so that the compensation current will be equal in magnitude and opposite in phase to the net interference current at the repeater output. Counter coupling circuits can be designed with the aid of a digital computer or by the hardware-iteration method, the latter being more suitable for railroad communication systems. It consists of measuring the phase-frequency characteristics of interference, selection of circuit components, and measuring the difference hodograph for the complete circuit with subsequent appropriate adjustment of components. A changeover from conventional K-24 to new K-60p transmission equipment along the South-West railroad route proceeds in two stages: first symmetrization of cables between two unattended repeater stations, also between an unattended one and an attended one, then concentrated suppression between attended repeater stations. Actual hodograph measurements indicate a higher interference immunity of the new system. Figures 9; tables 2.  
[251-2415]

UDC 681.3

# PARALLEL ALGORITHM OF FAST DISCRETE FOURIER TRANSFORMATION WITH COMBINED RECEPTION AND PROCESSING OF DATA

Leningrad IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 25, No 5, May 82 (manuscript received 1 Sep 80) pp 36-39

TSAREV, A. P., Kishinev Polytechnic Institute imeni S. Lazo

[Abstract] An algorithm is proposed for fast calculation of the coefficients of discrete Fourier transforms. This is a parallel algorithm which combines reception of input data and their processing, the latter with a reduced number of iterations regardless of the data volume and the input rate. The original data sequence of volume  $N = r^m$  ( $r \geq 2$ ) is subdivided into groups of

$M = r^g$  elements ( $M \ll N$ , positive integer  $g < m$ ) and a vector column  $C$  of dimension  $N^2/M$  is introduced which, when multiplied by the matrix product  $A = P \times I_{rm}$  ( $P$  - vector of  $N/M$  units,  $I$  - unit matrix), yields the vector-

column  $C$  of  $N$  coefficients of the discrete Fourier transform. In the process ( $m-g$ ) iterations are replaced with  $N/M$  periodic continuations of nonzero elements. The speed of this algorithm is characterized by the relation

$$\frac{M\Delta t}{T} \leq 1 \quad (\Delta t - \text{time interval between arrivals of elements of the original}$$

sequence,  $T$  - processing time for a current group of elements). Complete parallization is not always necessary; a parallel-series scheme can be adequate so that only  $N^2/Mk$  adders are needed ( $k$  - parallelization parameter) even though the processing time increases by factor  $k$ . The paper was recommended by the Department (Kafedra) of Automatic and Telemechanics. Figures 1; references: 3 Russian.  
[263-2415]

UDC 681.7.068

#### FIBER-OPTICAL ROTATION DETECTOR

Moscow RADIOTEKHNIKA in Russian Vol 37, No 4, Apr 82  
(manuscript received 1 Oct 81) pp 56-58

BUKHMANN, A. B., DIANOV, Ye. M., KARASIK, A. Ya., KOZLOV, V. A. and PROKHOROV, A. M.

[Abstract] Angular displacement of a reference system can be detected by means of a ring interferometer rigidly coupled to it, an interferometer where light rays coming from a source travel in opposite directions around the same closed path. In the present work the feasibility of using fiber optics for such an interferometer is examined on the basis of two possible experimental schemes. In one scheme all interferometer components, including light source and rotation detector, rotate at some angular velocity. In the second scheme the entire interferometer is stationary and only the coil with fibers rotates. The latter scheme is investigated more thoroughly. The theoretical problem in both is to determine the dispersion of the refractive index reliably. Practical problems are overcoming noise and improving the detector sensitivity. Noise signals are produced by monochromatic laser beams due to Rayleigh scattering and subsequent interference. Single-mode fibers are particularly suitable, although their intrinsic noise needs to be further reduced. Two-mode fibers severely limit the accuracy of measurements, mainly because of intermode conversion during temperature fluctuations and resulting light intensity redistribution. High detector sensitivity requires a  $\pi/2$  phase shift between both circulating light rays, which can be achieved through adjustment of the fiber-objective alignment or preferably through phase modulation of the light by means of a piezoceramic cell. The detector sensitivity is also limited by structural imperfections of the interferometer and insufficient rigidity of connections between its components. Figures 1; references 16: 5 Russian, 11 Western.  
[260-2415]

## LOSSES AT JOINTS IN OPTICAL FIBERS AT HIGH TEMPERATURES

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 3, Mar 82  
(manuscript received 12 May 80) pp 602-604

MARTYNOVA, T. A.

[Abstract] Two practical problems concerning optical quartz fibers (87-100% SiO<sub>2</sub>) and glass fibers (GeO<sub>2</sub>, Na<sub>2</sub>O, CaO, Li<sub>2</sub>O, MgO) are losses in a joint between two fibers at different temperatures and the temperature dependence of the loss in a joint between two fibers at the same temperature. Losses were calculated on a digital computer for joints with and without a gap, with and without an offset, using data on the refractive index of fiber materials at the 0.63 micrometer wavelength and on their coefficient of thermal expansion. Losses at T = 0°C were taken as the zero reference level. The author thanks V. V. Shevchenko and S. Ya. Fel'd for helpful suggestions and discussion of the results. Figures 2; tables 1; references 3: 2 Russian, 1 Western.  
[206-2415]

UDC 537.533.3

RIGOROUS SOLUTION OF ELECTROSTATIC PROBLEM WITH CALCULATION OF BOUNDARY ELECTRON TRAJECTORIES IN PERIODIC ELECTROSTATIC FOCUSING SYSTEMS WITH FINITE-THICKNESS ELECTRODES

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 3, Mar 82  
(manuscript received 19 Nov 80) pp 598-601

GRIBOVSKIY, A. V. and SAL'NIKOVA, L. P.

[Abstract] Trajectories of electrons moving through channels of periodic electrostatic focusing structures are calculated, taking fully into account the space charge, on the basis of a differential equation describing such a trajectory in a plane-symmetric or axisymmetric electrostatic field with a periodic Laplace potential. A numerical solution of this equation by the Runge-Kutta method confirms the existence of a zone of stable solutions and a zone of unstable solutions for such a potential. Included in the calculations are the boundary trajectories of plane-symmetric and axisymmetric electron beams, these trajectories depending on the initial channel fill factor and on the magnitude of the space charge. The results indicate a high sensitivity of periodic electrostatic focusing systems to the conditions of electron beam entry into the interaction space. Figures 4; tables 1; references: 4 Russian.  
[206-2415]

UDC 621.3.078

EVALUATION OF DIGITAL BAND ELIMINATION FILTERS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY; PRIBOROSTROYENIYE in Russian Vol 25, No 4, Apr 82 (manuscript received 12 Mar 81) pp 44-48

TIUNOV, S. S., Kuybyshev Polytechnic Institute imeni V. V. Kuybyshev

[Abstract] Nonrecursive digital band elimination filters are considered for "blanking out" a time series, such filters being more easily tuned to different

frequencies or stop bands than are recursive ones and their phase-frequency characteristic often being identically a zero-phase one. Synthesis of such filters by means of windows, directly rather than through more cumbersome weighting, is compared with synthesis by means of nonrecursive digital bandpass or narrow-band filters with linear phase-frequency characteristic requiring preliminary shifting of the series before subtraction from it. With the direct use of windows, it is necessary to shift only the major lobe of a given window in the spectrum to the center frequency of the band to be eliminated before subtracting the series at the output of the digital band pass filter from the original time series. Here the algorithms of both syntheses are evaluated comparatively from the standpoint of efficiency optimization. A subsequent numerical evaluation of various windows with regard to oscillations of the amplitude-frequency characteristic  $A(f)$  indicates that the Hamming window ensures the smallest edge effect and yields the smallest maximum oscillation of the  $A^2(f)$  characteristic. The paper was recommended by the Department (Kafedra) of Automatics and Telemechanics. Figures 2; references 7: Russian. [265-2415]

UDC 621.3.049.77

#### SYNTHESIS OF MULTISTABLE MULTIPHASE SYSTEMS WITH MULTIPLE-INPUT CONTROL

Moscow RADIOTEKHNIKA in Russian Vol 37, No 4, Apr 82  
(manuscript received after revision 13 Oct 81) pp 6-14

PLEKHANOV, S. P.

[Abstract] A method is proposed for synthesis and engineering design, on a basis of large-scale integration, of multistable multiphase systems with multiple-input control and with minimum number of components. It uses the generalized (composite) model of RS and D trigger circuits, with sets of bistable memory cells in both controlling and controlled automata. The method is universal and extremely simple, involves positive logic with minimal disjunctive and conjunctive normal forms in forward and inverse characteristic equations for all control signals. It covers basic universal control (and the two possible derived modes) as well as basic asynchronous control (and the seven possible derived modes), it provides for elimination of competing signals and makes use of convenient binary or other code tables. The procedure is demonstrated in a 3-input 5-stable 2-phase system with 2-input control in either of the two basic modes. Automatic design calculations for sequential and combination systems have been programmed in PL-1 for YeS Unified System computers. Figures 2; tables 5; references 8: Russian. [260-2415]

## FREQUENCY SYNTHESIZER USING COMBINED AUTOMATIC FREQUENCY-PHASE LOCKING

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 24, No 11, Nov 81 (manuscript received 19 May 80) pp 51-54

KARYAKIN, V. L.

[Abstract] A frequency synthesizer is considered which combines analog-digital automatic frequency-phase locking, with two coupled regulation loops. The phase locking loop around the tunable oscillator consists of a constant-divisor divider, a variable-divisor divider, a pulse phase detector, a low-frequency filter and a control circuit. The digital branch controlling the frequency of the tunable oscillator consists of a digital frequency detector and a reversible counter integrated with a digital-to-analog converter. The dynamic characteristics of such a synthesizer are analyzed on the basis of the fundamental equation of combined automatic frequency-phase locking, on the assumption that the phase detector characteristic is a  $2\pi$ -periodic sawtooth function of the phase difference between voltage of the reference oscillator and voltage of the tunable oscillator. This nonlinear differential equation is one with a discontinuous and ambiguous right-hand side, for which no regular method of exact solution is available. It is solved here by the method of point mapping, after it has been integrated over the interval in which the phase difference changes by  $2\pi N$  ( $N$  - divisor of divider in feedback circuit). The transient time for frequency and the transient time for phase, also the regulation error, are calculated on this basis. The transfer function of the low-pass filter is assumed to be equal to the transmission coefficient of the noninductive component in the control circuit and the relative frequency mismatch due to a change of code in the reversible counter by unity is assumed to be not larger than 2. Under this condition locking will occur regardless of the initial conditions and the locking band extends to the maximum possible mismatch which the digital branch of the frequency control system can compensate. The magnitude of mismatch determines the necessary speed of the synthesizer with given parameters. Figures 1; references: 3 Russian.  
[162-2415]

## DESIGN OF PIEZOELECTRIC ELEMENTS OF HIGH-FREQUENCY QUARTZ CRYSTAL RESONATORS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 26, No 12, Dec 81  
(manuscript received 24 Jun 80) pp 2531-2539

VESELOV, G. I., POSTNIKOV, I. I. and SAMOYLOV, V. S.

[Abstract] During development of high-frequency quartz crystal resonators used for filtration and stabilization of frequencies, a pressing problem is

the determination of the optimum geometry of the piezoelectric elements and the forms of the exciting electrodes for the most complete satisfaction of the specified requirements on the characteristics of the resonators. At present, however, it is not possible to find even the qualitatively basic regularity of connection of flexural and shear modes in the outlined piezo-elements. The present work is concerned with a solution to the problem of calculating the spectral characteristics of the outlined piezoelements, taking account of the connection of thickness-shear and flexural oscillations. The complexity of obtaining the solution for an anisotropic body leads to the necessity for an investigation of a simpler model - isotropic, making it possible to recognize the general properties of the outlined piezoelements in an isotropic approximation is obtained by the solution of a system of differential equations of motion. An analog-difference circuit is considered for which there are developed an algorithm and a program for a YeS computer using the Fortran-IV algebraic speech. It is concluded that the proposed algorithm for calculation of the characteristics of the piezo-elements of high-frequency quartz resonators makes it possible to analyze and forecast the fundamental properties of lens piezoelements as well as elements of circular symmetry of the outlined arbitrary shape. Figures 5; references 7: 5 Russian, 2 Western (1 in translation).  
[152-6415]

UDC 621.373.187.4:681.3.06

#### ANALYSIS AND DESIGN OF FREQUENCY SYNTHESIZERS BASED ON SURFACE-ACOUSTIC-WAVE FILTER MODULES

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 25, No 3, Mar 82 (manuscript received 7 May 80, after revision 13 Apr 81) pp 22-27

LOGINOV, V. I. and YAMPURIN, N. P.

[Abstract] A canonical algorithm of calculations for analysis and design of SAW filter modules as frequency synthesizers is shown, and two relevant problems of synthesizer parameters optimization are solved accordingly. The first problem is, with external (performance) parameters given and internal (design) parameters known, to determine the feasibility of synthesizing vibrations of high spectral purity and the required number of filter modules. This problem is solved using the method of whole-number programming. The second problem is, with external (performance) parameters given and the ranges of variation of internal (design) parameters known, to determine the optimum internal (design) parameters maximizing the radius of the active space. This problem is solved by the method of successive estimates. Figures 2; tables 1; references 6: Russian.  
[258-2415]

## OPTIMIZATION OF CONTROL CIRCUIT FOR TRACKING PHASE DEMODULATOR TO WIDEN ITS TRACKING RANGE

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 24, No 11, Nov 81  
(manuscript received 11 Jul 80, after revision 22 Dec 80) pp 35-40

ZAKHAROV, Yu. S. and NEVOLIN, V. I.

[Abstract] In tracking synchronous phase demodulators for reception of phase-modulated signals anomalously large errors appear which are caused by phase skipping by the controlled external oscillator. Immunity to such errors can be increased by widening the linear range of the phase detector characteristic to  $\pm\pi$  rad. Here the optimum structure of such a phase demodulator with the range of phase error possibly exceeding  $\pm\pi$  rad is synthesized on the basis of Pontryagin's maximum principle and the conditions of transversality. The demodulator constitutes an automatic control system which, in addition to the nonlinear phase detector, also includes a low-pass filter and an adder. Its dynamic behavior is described by a nonlinear differential equation, only a first-order one in this case. The optimum control is sought according to the high-speed criterion, namely shortest time of transition between two points in the phase space, considering also that the phase trajectories must satisfy the condition of stability. Calculations begin with the corresponding Hamiltonian, which is maximized on the optimum trajectory. A thus synthesized demodulator with widened range of phase error tracking has been tested in a system with noise generator, bandpass and rejection filters, variable attenuator and two square-law voltmeters. The range of anomalous phase errors was found to have shifted toward much higher input noise levels. Figures 5; references: 5 Russian.  
[162-2415]

## ESTIMATING RELIABILITY OF PROGRAMMABLE MATCHED SURFACE-ACOUSTIC-WAVE FILTERS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 25, No 3, Mar 82  
(manuscript received 15 Jul 80, after revision 31 Feb 81) pp 27-33

SMIRNOV, N. I. and KARAVAYEV, Yu. A.

[Abstract] Four different structures of programmable linear matched SAW filters are evaluated comparatively with respect to reliability. All structures include interdigital input-stage converters of electrical oscillations to mechanical vibrations (these devices having been produced by the

metallization process), tapped delay lines, polarity switching elements, and a reference register of binary sequences. Two of the structures are hybrid ones, with either separate or segmental group switching of electrodes. Two of the structures are monolithic, with epitaxial Si and AlN films on a sapphire substrate or MOSFET detectors on a silicon substrate. The probability of failure-free operation is calculated for each variant, on the basis of available data on failure intensity in their components. The results reveal no appreciable differences between the four variants, the monolithic one with epitaxial Si and AlN films on sapphire substrate being somewhat more reliable, inasmuch as the reference register is always the critical component. Figures 3; references: 9 Russian. [258-2415]

UDC 621.391.2

#### AUTOMATIC SELECTION OF ADAPTATION COEFFICIENT UNDER NONSTEADY CONDITIONS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 25, No 4, Apr 82 (manuscript received 17 Mar 81) pp 78-80

KUZ'MINSKIY, A. M.

[Abstract] Synthesis of adaptive filters for signals with unknown slowly varying characteristics involves replacement of a sequence of decreasing coefficients with some constant coefficient, which will determine the adaptation step in algorithms of stochastic adaptation. Under nonsteady conditions adaptive filters must, moreover, be capable of selecting the adaptation coefficient while processing the signals. An approximate algorithm of coefficient tracking and selection for recursive filters is compared with the algorithm of error minimization for a basic adaptive linear adder. Calculated respective excess mean-square errors and comparison of values of the adaptation coefficient according to the basic minimization algorithm with steady-state values of the adaptation coefficient according to the simpler approximate algorithm reveal that the latter algorithm, though slightly less accurate, is quite efficient and suitable for solving such problems. This has been confirmed analytically and also experimentally by simulation on a digital computer. Tables 1; references 4: 2 Russian, 2 Western. [262-2415]

## REFINED ESTIMATE OF ALGORITHMIC ERROR OF DISCRETE FILTERS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE  
in Russian Vol 25, No 4, Apr 82 (manuscript received 14 Sep 81) pp 35-38

KIRILLOV, V. Yu., Moscow Aviation Institute imeni S. Ordzhonikidze

[Abstract] The algorithmic error of a discrete filter is defined as  $\epsilon[nT] = |x_D(nT) - x_a(nT)|$  ( $n = 0, 1, 2, \dots$ ), i.e., the absolute values of the difference between input signal to discrete filter and output signal from analog filter-prototype at discrete instants of time  $t = nT$  ( $T$  - discretization interval). A refined estimate of this error is made by taking into account the order of interpolation based on Newton polynomials of the second kind and  $N$ -th order ( $N = 0, 1, 2$  for respectively stepwise, piecewise-linear, and quadratic interpolation). For illustration, these estimates are applied to a filter with infinite number of quantization steps ( $n \rightarrow \infty$ ) and a first-order discrete filter with an ideal analog filter-prototype.

References: 4 Russian.

[265-2415]

## ALGORITHM OF DISTRIBUTING OPERATIONS IN DIGITAL FILTER FOR MULTIPROCESSOR

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE  
in Russian Vol 25, No 4, Apr 82 (manuscript received 10 Jun 81) pp 39-43

SOTNIKOV, A. D., Leningrad Institute of Electrical Engineering of Communications imeni M. A. Bonch-Bruyevich

[Abstract] The speed of digital filters can be increased by distribution of calculation operations between several multiprocessors. Realization of such a system involves determining the class of structures capable of implementing the selected algorithm, comparatively evaluating the efficiency of this algorithm of digital filtration in parallel computers with various structures, and establishing the feasibility of synthesizing the selected structure with a specific type of multiprocessor. These three problems are solved here by the graph method. A procedure is shown by which directional graphs of computer structure and operations transfer are obtained from the signal graph. The paper was recommended by the Department (Kafedra) of Pulse and Computer Techniques. Figures 4; references: 5 Russian.

[265-2415]

## COMMUNICATIONS

UDC 621.3.018.78

### COMPENSATION OF TRANSIENT PROCESSES DURING TRANSMISSION OF FREQUENCY-MANIPULATED SIGNALS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 24, No 11, Nov 81 (manuscript received 3 Jun 80, after revision 15 Dec 80)  
pp 85-87

BRYUKHANOV, Yu. A.

[Abstract] When frequency-manipulated signals pass through a tuned oscillatory circuit operating with fixed frequency deviation, then transient processes can be compensated by means of predistortion in the form of additional phase manipulation and short rectangular radio pulses. This method is based on the response of a single-stage tuned amplifier with a parallel tank circuit to a voltage signal with complex envelope. Calculations reveal that partial compensation by means of additional phase manipulation alone is also feasible. In the special case of zero frequency deviation the additional phase jumps in adjacent trains differ in sign only and there is no need for additional voltage. Inasmuch as the magnitudes of phase jumps depend uniquely on the sign of the frequency jump, one can take the voltage for controlling the predistortion from the modulating voltage of the FM (frequency manipulation) signal generator and thus compensate during random tracking of trains in the out-going signal. Figures 2; tables 1; references: 2 Russian.  
[162-2415]

## ELECTROMAGNETIC COMPATIBILITY BETWEEN SECONDARY SWITCHING POWER SUPPLIES AND RADIOELECTRONIC EQUIPMENT

Kiev TEKHNIЧЕСКАЯ ЭЛЕКТРОДИНАМИКА in Russian No 2, Mar-Apr 82  
(manuscript received 8 Apr 81) pp 27-34

SHIROKOV, V. L., Leningrad Institute of Aircraft Instrument Design

[Abstract] Development and proper design of secondary switching power supplies for radioelectronic equipment requires an analysis of the physical phenomena producing electromagnetic noise in the switching elements of such power supplies. Such an analysis, usually performed with the aid of simulation techniques, must cover the three areas of low-frequency electromagnetic processes underlying the operation of switches, high-frequency oscillations during switching events, and interference from transient processes in the input stages. Problems in all three areas are related, inasmuch as the paths of electromagnetic noise and interference signals must be traced. An important part of the study are measurements of interference parameters and of equipment parameters. Electromagnetic compatibility can then be ensured by various techniques classifiable into four groups: 1) Optimization of the converter topology and circuit design; 2) Passive filtration; 3) Shielding and suppression of parasitic couplings; and 4) Grounding. Figures 2; references 37: 20 Russian, 17 Western (1 in translation).  
[257-2415]

## CONVEXITY CONDITIONS FOR GENERALIZED CHARACTERISTICS OF RESOLVERS IN CHECKING RELIABILITY OF SIGNAL RECEPTION WITH BACKGROUND INTERFERENCE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 3, Mar 82  
(manuscript received 18 Jul 79, after correction 27 Jul 81) pp 438-446

SINDLER, Yu. B.

[Abstract] Optimization of resolvers used in receivers for checking the reliability of signal extraction from background interference depends on the convexity of their generalized characteristics in the space of all quality indicators. This convexity and conditions ensuring it are analyzed in the present paper by the conditional-extremum method, which involves solution of the corresponding minimization problem by determining the saddle point and sorting the possible realization variants. Both deterministic and randomized conversions of input signal to output signal are considered, the most common case being an array of finite discrete signals at the input. Alternatives to the MABR (minimum average Bayes risk) optimization criterion are examined which do not require that the cost function which is rather difficult to define adequately be given. Figures 2; references 17: 16 Russian, 1 non-Russian in translation.  
[206-2415]

## DISTRIBUTION OF MAXIMA IN SEQUENCE OF CORRELATED READINGS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 3, Mar 82  
(manuscript received 11 Apr 80) pp 447-450

REMBOVSKIY, A. M.

[Abstract] Digital processing of signals involves sequences of correlated readings, the statistical characteristics of these sequences generally differing from those of the continuously varying voltage from which they are generated. The distribution of the number of maxima and of the absolute maximum can be estimated on the basis of a connected discrete Markov chain as the mathematical model, with states characterized by a set of matrix-columns and a matrix of transition probabilities. A comparison of results with those obtained by simulation using a generator of random numbers indicates a satisfactory accuracy of this method. Figures 2; tables 1; references 5: 4 Russian, 1 Western.  
[206-2415]

## MULTICHANNEL METHODS OF PROCESSING COMPLEX COMPOUND SIGNALS WITH USE OF WALSH FUNCTIONS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 3, Mar 82  
(manuscript received 7 May 80, after correction 4 Aug 81) pp 451-456

SALOMATIN, S. B.

[Abstract] Multichannel processing of complex compound signals on the basis of Walsh functions, with the aid of special fast transformations, is demonstrated on a  $2^{2n}$ -valued compound signal  $S_1^{2n}$  with a linearly varying number of zero crossovers and a  $2^{2n+1}$ -valued compound signal  $S_2^{2n+1}$  with a symmetric linearly varying number of zero crossovers. The periodic autocorrelation function of each signal is determined, including its level of maximum lateral peaks, whereupon recurrence relations through Rademacher functions are established for the thin structure of such signals. This is followed by successive periodic and aperiodic transformations of the matrix of even cyclic shifts in the  $S_2$  signal. Figures 1; tables 1; references: 6 Russian.  
[206-2415]

## SYNTHESIS OF ASYMPTOTICALLY OPTIMUM ALGORITHMS FOR DETECTION OF WIDEBAND SIGNALS IN AMBIENT NOISE MIXED WITH NARROW-BAND NON-GAUSSIAN INTERFERENCE

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 25, No 4, Apr 82  
(manuscript received 21 Apr 81, after revision 20 Oct 81) pp 30-35

ULANOV, A. Ye.

[Abstract] The structure of a receiver for optimum detection of wideband signals in noise with an admixture of narrow-band non-Gaussian interference is synthesized on the basis of asymptotically optimum detection algorithms. The entire spectrum of the input process  $x(t)$  is subdivided into  $m$  frequency intervals so that, with the aid of band filters, noise bands also containing strong narrow-band interference can be extracted. The subsequent procedure involves testing asymptotic expansions as the sample size approaches infinity and in this way eliminating a priori indeterminacies. The algorithm of detecting a deterministic signal with a certain characteristic with yields the maximum signal-to-noise ratio is found to be the asymptotically optimum one. The receiver implementing such an algorithm consists of a two-stage multichannel nonlinear parametric filter at the input, the filter stages separated by an inertialess nonlinear converter whose instantaneous characteristic largely determines the asymptotic properties of the logarithm of the asymptotically expanded likelihood ratio, then an optimum weighting channel adder, and a correlator followed by a threshold device at the output. Figures 3; references: 6 Russian.  
[262-2415]

## TWO-STAGE SIGNAL EXTRACTION FROM NOISE OF UNKNOWN LEVEL

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 25, No 3, Mar 82 (manuscript received 27 Nov 80) pp 78-80

VOSTRETISOV, A. G.

[Abstract] The problem of signal extraction from an additive noise of unknown fluctuation power is solved by noncoherent detection in two stages, utilizing the "contrast" between statistically independent signals reflected by two neighboring elementary resolution elements in a radio communication line. Both signals have a normal distribution of instantaneous values with an unknown dispersion. The first stage of the process is binary quantization of input data, resulting in a system of two equations for two unknowns (probability of a 1 appearing at the quantizer output in absence of useful signal, and detection threshold). In the second stage the binomial distribution of 1's at the quantizer output, with a large  $n$  characteristic of noncoherent

detection, is replaced with a normal distribution and the two equations are transformed accordingly so that the two sought unknowns will not depend on the signal-to-noise ratio. A detector built on this basis is characterized by a constant false-alarm probability, requires no automatic gain control for matching the noise level, and has maximum power in the class of detection rules with preliminary binary quantization. Figures 1; references: 6 Russian. [258-2415]

UDC 621.391.2

# RECONSTRUCTING GENERATOR OF M-SEQUENCES FROM SEGMENT OF SUCH SEQUENCE

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 24, No 11, Nov 81 (manuscript received 10 Nov 80) pp 95-96

TOMILO, O. G.

[Abstract] Generators of M-sequences are constructed on the basis of irreducible and primitive polynomials or transition matrices. When none of these but only  $n$  arbitrary consecutive numbers of such a sequence are known, it may be possible to reconstruct the generator. This is demonstrated on an M-sequence  $\{d_k\}$  with period  $N = p^m - 1$  where the value of any number  $d_k$  ( $k = \overline{m+1, N}$ ) has been represented in the form of the linear recurrence relation

$$d_k = \sum_{i=1}^m C_i d_{k-i}, \pmod{p} \text{ for } m \text{ given initial numbers } d_k \text{ (} k = \overline{1, m} \text{)}.$$

Calculating the vector of C-coefficients from the known state vectors  $V(j), V(j+1), \dots, V(j+m)$  and corresponding vector-column  $B = [V_1(j+1), \dots, V_1(j+m)]'$  requires  $n=2m$  numbers of the M-sequence. When  $m$  is not known, then the corresponding system of  $m$  linear equations must be set up and solved for  $m_1$  known to be larger than  $m$  and with coefficients  $C_i = 0$  for  $i > m$ . This system does not have a solution when the original  $\{d_k\}$ -sequence is not an M-sequence. References: 3 3 Russian. [162-2415]

UDC 621.391.14:519.2

# USE OF SECONDARY ORTHOGONAL TRANSFORMS FOR CLASSIFICATION OF SIGNALS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 25, No 5, May 82 (manuscript received 10 Jul 81) pp 3-7

ALEKSEYEV, M. A. and SOLODOVNIKOV, A. I., Leningrad Institute of Electrical Engineering imeni V. I. Ul'yanov (Lenin)

[Abstract] The problem of classifying  $M$  discrete random signals  $X^m$  is solved by determining the operator which will transform vector  $X^m$  into vector  $V^m$  of

informative indicators which adequately characterize the original signals. For this are first selected a transformation operator and a criterion for estimating the indicators. An orthogonal linear transformation and a spectral operator are conventionally used for this purpose, but here a single transformation such as the Karunen-Loewe transformation (optimum with respect to minimum entropy) is found not to be most expedient. Multistep orthogonal transformation is proposed instead, namely Fourier transformation (invariant with respect to arithmetic shifts of input signal) and subsequent normalization for constructing the vector of informative indicators. This method has been applied to classification of electroencephalograms and found to be 93% efficient. The paper was recommended by the Department (Kafedra) of Automatics and Control Processes. Figures 1; references: 4 Russian.  
[263-2415]

UDC 621.391.17

# INTERFERENCE IMMUNITY OF STANDARD CHANNEL DURING DETECTION OF SIGNALS WITH FLUCTUATING AMPLITUDE

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY; RADIOELEKTRONIKA in Russian  
Vol 25, No 4, Apr 82 (manuscript received 22 Sep 81) pp 92-95

PARKHOMENKO, A. N. and SHOTSKIY, B. I.

[Abstract] A standard detection channel for radar and radioacoustics consists of a square-law detector preceded by an ideal band filter and followed by an ideal integrator. Here is considered a practical variant of such a channel, with a single-stage resonance circuit as filter-preselector and an integrating RC circuit without switching. Its interference immunity is calculated on the basis of standard relations for the detection characteristics, for an echo signal with random initial phase uniformly distributed over the  $0, 2\pi$  interval and a random nonzero amplitude having a Rayleigh probability distribution. A comparison with the ideal standard channel indicates that the characteristics of an optimum receiver are practically attainable by parallel shifting of the  $(1 - D)$  vs  $q^2$  curves (straight lines) along the  $q^2$ -axis ( $D$ - correct-detection probability,  $q^2$ - signal-to-noise ratio at output). Design calculations are facilitated by use of  $q^2_{\text{real}}/q^2_{\text{opt}}$  ratio determining the energy loss due to nonoptimality. The calculation error does not exceed 0.5 dB with  $D > 0.5$  (false-alarm probability  $F < 10^{-2}$ ). Figures 3; references: 3 Russian.  
[262-2415]

## PROCESSING OF MULTIBEAM SIGNAL IN DISTRIBUTED-PARAMETER SYSTEM

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 25, No 4, Apr 82  
(manuscript received 7 May 81, after revision 22 Jun 81) pp 88-89

KULESHOV, Yu. G.

[Abstract] Theoretical study of processing a multibeam radio signal is continued in order to determine the feasibility of adding the processed signal components and thus approaching the potentially attainable Kotel'nikov limit of interference immunity. A reference oscillation containing all non-informative "address" parameters needed for signal identification and the distorted radio signal are both applied to opposite inputs of a segment of a distributed-parameter transmission line, the radio signal described by an integral in a form which represents discrete beam distributions as well as the extreme case of a continuous distribution. Interaction of waves produced by these oppositely traveling signals will, in a transmission line with a sufficiently large and nonlinear distributed reactance, result in compound oscillation modes with series of harmonics at each point of the transmission line segment. Full compensation of the reference signal demodulation is always possible with a properly selected phase modulation of both signals. Thus signal processing by various methods appears to be feasible.

References: 5 Russian.  
[262-2415]

## INTERFERENCE IMMUNITY OF ADAPTIVE ALGORITHMS OF NOISE SIGNAL DETECTION

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 25, No 4, Apr 82 (manuscript received 19 Jun 81) pp 96-98

PADIRYAKOV, Yu. A. and MAZOR, Yu. L.

[Abstract] Three adaptive algorithms for detection of noise signals are compared with respect to interference immunity. One is synthesized by maximization of simultaneous probability densities of two samples with respect to unknown parameters, one sample a priori known to be either the sum of signal and interference or interference alone and the other sample a priori known to be interference alone. The second algorithm is based on estimates of spectral power densities of interference and signal+interference mixture. The latter algorithm is also modified to a third one by change from power density to energy variables with subsequent superposition of measurement time and adaptation time on observation time of equal lengths. All three algorithms have nearly Gaussian probability densities, according to the central-limit

theorem, and their interference immunity is calculated on this basis for a certain class of signal and interference models. The results indicate that the first algorithm is most immune in the case of a narrow-band noise signal with unknown frequency within a wide range and the last algorithm is most immune in the case of wideband signals with complex spectrum.

References: 2 Russian.

[262-2415]

UDC 621.391.83

#### CORRELATION CHARACTERISTICS OF ENSEMBLES OF FILTERED QUASI-NOISE SIGNALS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 25, No 4, Apr 82 (manuscript received 13 Apr 81) pp 80-83

VAKKER, R. A.

[Abstract] The autocorrelation function of an ensemble of filtered quasi-noise signals is calculated by convolution of the autocorrelation function of the aperiodic input process and the autocorrelation characteristic of the filter, with subsequent double integration by parts and differentiation involving the envelope in the range of strong correlation and the unit-step function. The statistical characteristics of lateral correlation residues on the output side, which affect detection of weak signals in strong noise, and the ambiguity of output readings are then determined from the envelope of the output ensemble and the lateral correlation residues in the aperiodic input process. Figures 3; references: 4 Russian.

[262-2415]

UDC 621.391:681.518.2

#### ALGORITHMS OF MULTICHANNEL KALMAN FILTRATION

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 25, No 4, Apr 82

(manuscript received 27 Jan 81, after revision 29 Jun 81) pp 49-54

GRISHIN, Yu. P.

[Abstract] Optimum data processing in real time with multichannel radio engineering measurement systems may become unfeasible as the number of channels increases. Sub-optimum algorithms reduce the unwieldiness of computations, but also the effectiveness of such a system. As an alternative, modification of optimum multichannel filtration algorithms are considered here. The feasibility of synthesizing three Kalman filters, parallel, sequential and with data precompression, is examined for a specific application: estimating a discrete random process  $x(k)$ , describable by a linear difference equation, from readings  $y(k)$  of an  $M$ -channel instrument. The three filtration

algorithms are compared regarding the number of multiplication involved for various dimensionalities of vectors  $x(k)$ ,  $y(k)$ . The filter with precompression of input data is found to be most efficient in this respect, the sequential filter requiring most computations. Figures 3; tables 2; references 3: 2 Russian, 1 Western.  
[262-2415]

UDC 621.395.5

#### DIGITAL SEPARATION OF SIGNALS WITH RESPECT TO FREQUENCY BY METHOD OF BUNCHING FILTRATION

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 25, No 4, Apr 82 (manuscript received 4 May 81) pp 54-62

KLYAZNIK, V. V.

[Abstract] The problem of digital separation of  $M$  frequency-channel signals in an input signal is formulated in terms of filter performance, specifically the attenuation-frequency characteristic and the various requirements which may be imposed on it. Bunching filtration, an alternative to separate filtration, is based on the periodicity of the amplitude-frequency characteristic of digital filters. It involves narrowing, in several stages, the frequency band occupied by the signals with subsequent increase of the discretization period each time and multiplexing all resultant signals into one. Algorithms of such filtration yield the same signals at the output of a digital filter array as do algorithms of separate filtration, but they are either much simpler or much faster - especially as the number of channels increases. A particular algorithm is most expediently constructed after the filter staging has been optimized on the basis of given system parameters and application. Figures 1; tables 1; references 4: 3 Russian, 1 Western.  
[262-2415]

UDC 621.396

#### ESTIMATE OF MEAN-SQUARE ERROR OF NONLINEAR TRACKING MEASURING DEVICE IN CASE OF STRONG FLUCTUATION INTERFERENCE

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 25, No 4, Apr 82 (manuscript received 10 Nov 81) pp 76-78

FEDOSOVA, A. I.

[Abstract] A method is proposed for estimating the error of nonlinear tracking measuring devices in the transient mode of operation in ambient fluctuation interference and white noise. The structure of such a device

consists essentially of a discriminator, a smoothing filter and an amplifier-converter. With the dynamic error disregarded, the error signal can be approximated with a Markov process and the probability density of transition from error  $x$  to error  $y$  within time  $t$  satisfies the Fokker-Planck-Kolmogorov equation. The inverse Fokker-Planck-Kolmogorov equation is reduced to  $\dot{P} = LP = -a(x)\partial P/\partial x + (b_0/2)\partial^2 P/\partial x^2$  and solved for the case of strong interference, in the range where the discriminator characteristic becomes nonlinear, with constraints on the magnitude of the estimation error. A theorem pertaining to the upper limit of the exact solution which is easily proved with aid of the maximum principle for parabolic differential equations yields inequalities from which both mean and mean-square errors of measurement can be calculated. The discriminator characteristic  $D(x)$  does not have to be linearized, the only requirement being that  $D(x)/x > 0$ . Curves of error as function of time have been plotted by this method for a typical instrument with  $a = \tanh x$ ,  $b_0 = 1$ ,  $x = 0.25$  ( $-\gamma \leq x \leq \gamma$ ,  $\gamma = 0.5$ ). Figures 3; references: 4 Russian. [262-2415]

UDC 621.396.6

#### SUBOPTIMUM RECEPTION OF SIGNALS WITH REDUNDANCIES

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 25, No 4, Apr 82 (manuscript received 10 Nov 80) pp 43-48

NAUMOV, A. S.

[Abstract] Use of compound signals with a binary component, and with application of the maximum-likelihood principle, is considered for transmission of discrete messages with interference immunity. Suboptimum algorithms of reception of "signals with redundancies" are preferable in this case, because they are much simpler and not much less interference immune than an optimum one. A sufficiency theorem pertaining to the system of code verifying equations for sequences of binary signals thus transmitted serves as a universal basis for comparatively evaluating known suboptimum algorithms (Wagner, Chase, Kagan-Fink, modified rank algorithm) as well as for constructing new ones. Such a new algorithm of obtaining a general solution which satisfies the conditions of the theorem is shown here and compared with the four known ones. References 9: 8 Russian, 1 Western. [262-2415]

# METHODOLOGY OF DETERMINING OPTIMUM PARAMETERS FOR TUNABLE COMPONENTS OF ENGINEERING SYSTEMS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 25, No 11, Nov 81

(manuscript received 9 Apr 80, after revision 1 Dec 80) pp 77-78

AVKHACH, M. Ya., IGNATOV, A. A., KRASNOV, I. A. and SAUSHEV, A. V.

[Abstract] A theoretical-experimental methodology is proposed for determining the optimum tolerance limits for the maximally permissible quantization step of parameters of tunable system components with an arbitrary number of output characteristics, taking into account both the technological spread of parameters of complementary parts and the diversity of service conditions. It is based on statistical simulation with use of data on performance limits. The procedure involves first forming  $n$  lots (minimum number of samples, without spares, within 25-50) of active elements with arbitrary values of parameters and one lot of passive elements with nominal values of parameters, then assembling a system model with passive elements and one of the lots of active elements. The optimum tolerance limits for each tunable parameter are established on the basis of shortest paths of their further narrowing according to appropriate criteria, whereupon the maximum permissible quantization step is established for each parameter with service conditions taken into account. Next is formed a system of passive elements with nominal values of parameters and one lot of active elements with values of parameters closest to the mean value of the random quantity, which characterizes the probability of the system being operative and serves as criterion for narrowing the tolerance limits. The procedure is repeated for all passive elements and the tradeoff region is determined, if it exists. When no tradeoff region is found at first, then the effect of each passive element on the performance limits is determined in arbitrary sequence and the performance limits narrowed to exclude the range which corresponds to changes in the parameters of elements most strongly affecting it. Here deterioration in service and life expectancy are also considered. References: 5 Russian. [162-2415]

# OPTIMAL RECEPTION AND PROCESSING OF INTERFERENCE PULSE RADIO SIGNALS WITH MOBILITY OF RECEIVER CARRYING OBJECT TAKEN INTO ACCOUNT

Moscow RADIOTEKHNIKA in Russian Vol 37, No 4, Apr 82  
(manuscript received 22 Apr 81) pp 49-55

RYABTSOV, A. L.

[Abstract] The problem of optimal reception and processing of radio interference pulses is solved according to the Markov theory of optimal nonlinear

filtration for a receiver mounted on a moving object such as a ship or aircraft. The arrival times of useful forward and reflected radio signals are unknown, their phases are random quantities, the time delays of reflected signal and interference pulse relative to forward signal are nonstationary random processes. The receiver input signal is an additive mixture of useful signal and interference pulse, the latter being a stationary Gaussian white noise with known characteristics and the former being the result of interference of forward and reflected signals. The error of estimating the vector of state variables is calculated on this basis and the nonstationary component of a given state variable is found to affect the accuracy of filtration of the time delays. An optimal receiver on a mobile object is accordingly synthesized as a combination of channels, their number equal to the dimensionality of the state vector, which will quasi-coherently process radio interference pulses. Figures 3; references: 5 Russian.  
[260-2415]

UDC 621.396.62

#### GENERALIZED PARAMETER OF FREQUENCY SELECTIVITY FOR RECEIVER OF DISCRETE SIGNALS

Moscow RADIOTEKHNIKA in Russian Vol 37, No 4, Apr 82  
(manuscript received, after completion, 15 Sep 81) pp 44-49

BREUS, A. I.

[Abstract] The selectivity factor  $S = 2w/w_{\text{sup}}$  is proposed as a generalized parameter of selectivity, where  $2w$  is the required pass band and  $w_{\text{sup}}$  is the band of signal suppression by sinusoidal interference. The latter concept has been defined more precisely, namely in terms of suppression to the 20% level. Here the selectivity factor and the suppression band are applied to a noncoherent receiver of frequency-shift keying signals, taking into account channel nonlinearity with attendant enhancement of the spectrum and change in the signal-to-interference ratio. Expressions are derived for the suppression band and the error probability which include the effect of intrinsic receiver noise. The normalized suppression band or the selectivity factor can now serve as a generalized parameter for design and performance calculations based on error probability as the criterion. Figures 3; references: 4 Russian.  
[260-2415]

## EXTRACTION OF RADIO PULSE SIGNALS OF USEFUL FREQUENCY CHANNEL

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY; RADIOELEKTRONIKA  
in Russian Vol 25, No 4, Apr 82 (manuscript received 10 Nov 81) pp 70-72

OZERSKIY, Yu. P.

[Abstract] Reliable extraction of signals of the useful frequency channel in multichannel radio communication systems is particularly difficult when the frequency spectra of adjacent channels overlap. The receiver selectivity in this case is conventionally improved by means of a compensator consisting of two or more oscillatory circuits, amplitude detectors and a weighting subtractor of their output voltages. Calculations based on the frequency characteristic of such a compensator and its response to sinusoidal and rectangular signals reveals that the maximum attainable signal-to-noise ratio is only 0.4-0.6 and thus lower than that attainable by matched filtration of the useful signal. More effective other means of extracting the useful signal include resolver logic devices, one placed in each channel and connected to those in adjacent channels. The device invented by this author, USSR patent disclosure No. 491,193 (1975), consists of two parallel matched filter-detector branches and a coincidence circuit, one detector followed by a comparator logic with inputs for signals from other channels and with an output to the coincidence circuit through a generator of gate pulses triggering it, the other detector is followed by this coincidence circuit through a delay line. Figures 3; references: 10 Russian, [262-2415]

## DETECTION ALGORITHMS FOR NONRECTANGULAR PULSE PACKET

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY; RADIOELEKTRONIKA in Russian  
Vol 24, No 11, Nov 81  
(manuscript received 15 Apr 80, after revision 26 Mar 81) pp 66-67

ZUYEV, S. A.

[Abstract] Optimum detection algorithms for a nonrectangular pulse packet with known beginning and end are constructed on the basis of the "k out of n" criterion. Expressions for correct-detection probability and false-alarm probability are written for the specific case of a completely known signal in additive normal white noise. The correct-detection probability is then maximized so that optimum number k of pulses in the packet with a given envelope will be processed. The procedure is demonstrated on determination of  $k_{opt}$  for four packets of  $n = 5$  pulses with ramp, sinusoidal, staircase, flat envelope, respectively, and  $k_{opt}$  found to be 3 or 4. Figures 1; references: 5 Russian, [162-2415]

DEPENDENCE OF INTERFERENCE IMMUNITY OF FREQUENCY-TELEGRAPH SIGNAL  
RECEPTION WITH FILTERING ON LAWS OF PULSE INTERFERENCE DISTRIBUTION

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 24, No 11, Nov 81 (manuscript received 27 Jun 80) pp 63-65

BATRAYEV, V. P. and FOMIN, A. F.

[Abstract] Immunity of frequency telegraphy to pulse interference is analyzed, assuming that the FT signals appear in a receiver containing a set of identical channel filters and that the pulse interference at the filter outputs consists of overlapping single pulses produced by impact excitation of the filters. Conditional probability of FT symbol identification error and ratio of signal power to mean-square pulse interference amplitude are calculated for four different pulse interference distributions: Rayleigh, exponential, hyperbolic and logarithmic. A log-normal distribution is found to be most universal, with  $\sigma > 0.83$  generally such a distribution and a hyperbolic one being most dangerous to correct signal detection. Figures 1; tables 1; references: 5 Russian.  
[162-2415]

## QUASI-OPTIMUM RECEPTION OF NOISE SIGNALS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 25, No 4, Apr 82  
(manuscript received 8 Oct 80, after revision 23 Mar 81) pp 36-43

MAZOR, Yu. L.

[Abstract] The problem of detecting a weak stationary Gaussian noise signal in ambient stationary Gaussian interference is solved by means of a quasi-optimum receiver, namely an adaptive one with an asymptotically optimum interference immunity. When the a priori unknown signal and interference spectra decrease monotonically, then the optimum detection rule does not necessarily ensure the minimum a posteriori risk. The efficiency of such a receiver, consequently low in the range of weak noise where interference immunity is most easily attainable, can be improved by abandoning universal algorithms and using partial a priori data about the signal. This principle is applied here, accordingly, to the specific case of Gaussian noise  $G_s(\omega) = A\omega^{-m}$  and Gaussian interference  $G_i(\omega) = B\omega^{-n}$ . The laws according to which the two spectra vary in time are assumed first to be a priori known and then to be a priori indeterminate. In the second step the problem has been reduced to selection of weight factors for the quasi-optimum processing, either empirically through preliminary adaptation or on the basis of a priori data. A numerical evaluation of the loss of immunity relative to optimum processing reveals that adaptation with respect to only a few parameters will

already be adequate. Replacement of universal algorithms shortens the adaptation time. Figures 3; tables 2; references: 6 Russian.  
[262-2415]

UDC 656.254:621.395.345

#### INTRODUCTION OF TYPE YeSK-400Ye QUASI-ELECTRONIC AUTOMATIC TELEPHONE OFFICES

Moscow AVTOMATIKA, TELEMEXHANIKA I SVYAZ' in Russian No 3, Mar 82  
pp 25-27

GRINBERG, M. G., senior engineer, communications laboratory for the South-West route

[Abstract] Quasi-electronic automatic telephone offices are more reliable, smaller and more versatile than ten-step automatic ones and are, for this reason, being introduced into the communication system for the South-West route. The modular YeSK 400Ye model is produced in Bulgaria but is very easily adaptable for installation and operation here. The changeover was begun after a thorough study and is proceeding according to a schedule prepared for soonest possible completion, with provisions for necessary connections to other equipment, to counterpart existing automatic telephone offices and to subscribers, also for continuity of service, for adequate instruction of operation personnel and subscribers, for maximum economy and utilization of standard auxiliary equipment. Operating experience so far indicates a high reliability of this equipment. However, maintenance requires prompt replacement of faulty modules and thus their prompt identification by skilled personnel. Figures 1; tables 1.  
[251-2415]

#### IMPROVING RELIABILITY OF K-1920 AND K-1920U TRANSMISSION SYSTEMS

Moscow VESTNIK SVYAZI in Russian No 3, Mar 82 pp 30-32

INGBERMAN, M. I., candidate of technical sciences, MENG, V. A., chief engineer of territorial control center No. 3 for interurban telephone communication with television, IVANOV, V. V., chief of supervisory technical management service, RAPOPORT, B. S., chief of production laboratory, YEVGEN'YEVA, L. A., engineer, STOLYAROV, A. M., chief of semiautomatic logging station service, and BORISOV, A. I., chief of laboratory, Central Scientific Research Institute of Communications

[Abstract] The reliability of coaxial communication trunks with K-1920 equipment depends largely on the operation of 6Zh49P-DRU and 6E6P-DRU vacuum tubes in the line amplifiers, their failure rate being 1.84-3.14%

at nominal 6.3 V filament voltage. New techniques have been developed at the territorial control center No. 3 for interurban telephone communication with television which make it possible to schedule triennial programs of tube replacement in unattended and attended repeater stations. These techniques extend the tube life to 30,000 h in four ways. Reducing the filament voltage to  $5.7 \pm 0.2$  V with a transformer and a potentiometer stabilizes the transconductance and the plate current while also lowering the cathode temperature. Conditioning with an ion sorption pump further deepens the vacuum and prevents cathode poisoning by residual gases. Ion bombardment of the plate prevents gas formation as a result of electron bombardment and subsequent cathode poisoning by "anodic" gases. High-voltage treatment, namely removal of impurities by electrolysis, increases the electrical strength of the Alundum insulator in the cathode-heater gap. In addition to the equipment for implementing these measures, there have also been developed methods of tube testing and inspection at the factory and in the field laboratory. The data already available confirm the effectiveness of these improvements. [252-2415]

#### SOME PROBLEMS IN PRODUCTION INTENSIFICATION FOR ECONOMICAL RADIOFICATION

Moscow VESTNIK SVYAZI in Russian No 4, Apr 82 pp 40-42

SHAMSHIN, I. A., chief engineer MGRS (possibly Moscow City Wire Broadcasting Network or Moscow Municipal Radio Relay Network)

[Abstract] Radiofication of the USSR has become vast in scope, following the trends in population and in technological development, but is not yet managed most effectively and economically. The two major objectives should be: 1) More intensive utilization of labor resources, considering that labor cost exceeds more than half the total cost of radiofication while there is a shortage of personnel especially at the technician level and overstaffing in other areas; and 2) More intensive utilization of financial resources for equipment modernization, outstanding examples being changeover to transistorized components and optimization of the radio network layout. References are made to activities of the Scientific Research Institute of Radio Broadcasting and the Central Scientific Research Institute of Communications, with recommendations on where their efforts should be channelled and intensified. Comparisons are drawn with trends in the United States and in Czechoslovakia, where lessons can be learned by the professional engineering staff. The author finally examines how the technological state of the art, labor practices, and product quality control criteria affect production in the radio industry. He points out the need for more flexibility and diversification, even circumvention of existing rules and procedures. [266-2415]

UDC 621.372.832

IMPROVING DIRECTIVITY OF PRINTED-CIRCUIT STRIPLINE COUPLERS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 25, No 3, Mar 82 (manuscript received 4 Aug 80, after revision 1 Jun 81)  
pp 11-16

SLEDKOV, V. A., LERER, A. M. and RYAZANOV, V. D.

[Abstract] An experimental study was made of four different directional couplers on printed-circuit striplines, for the purpose of comparative evaluation and subsequent design optimization. Most technological are strip-lines with lateral coupling, maximum directivity being achieved with substrates of SA 3.8-F material (dielectric constant 3.8) and an air interlayer over the coupling region. Performance characteristics of such a coupler, as well as of the others, were measured in the frequency bands 1-6. Here the experimental data are compared and found to closely agree with theoretical calculations. Figures 4; tables 1; references 21: 11 Russian, 10 Western. [258-2415]

UDC 621.373.42

COMPUTER-AIDED ANALYSIS OF FLUCTUATION CHARACTERISTICS OF TRANSISTOR POWER AMPLIFIERS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 24, No 11, Nov 81 (manuscript received 21 Apr 80, after revision 5 Dec 80)  
pp 3-10

ABLIN, A. N., MOGILEVSKAYA, L. Ya. and KHOTUNTSEV, Yu. L.

[Abstract] High frequency stability of a receiver and its ability to detect weak signals depend on the fluctuation characteristics of its nonlinear component devices. In the present paper the fluctuation characteristics of a transistor power amplifier are analyzed on the basis of a nonlinear modification of the Hamilton model. This model of a bipolar transistor includes sources of thermal noise of base resistance, generation-recombination noise in emitter and collector junctions, intrinsic noise in emitter junction, and

thermal noise in emf-generator resistance. For small current and voltage increments, because of weak signals, the nonlinear system of equations is replaced by a linear one with differential parameters which vary in time. These parameters, defined relative to steady-state quantities, are differential conductance, differential barrier capacitance and differential diffusion capacitance of both emitter junction and collector junction. The relations for the energy spectra of all noise components are put in matrix form, for convenient computer-aided evaluation over wide noise frequency spectra. Calculations made on a YeS-1020 Unified System computer for 100 MHz and 350 MHz power amplifiers with power rating from 0.05 to 0.3 W reveal the effects of periodic nonstationarity and parametric frequency conversion of generation-recombination noise and intrinsic noise. In the case of a KT904 power transistor with a typically low base resistance of 2 ohms, increasing the power input from 0.05 to 0.2 W was found to decrease the ratio of noise power to signal power by 30 dB. Figures 2; references: 7 Russian. [162-2415]

UDC 621.396.664(088.8)

#### OPTICAL TELEVISION DEVICE FOR INSPECTION OF PRINTED-CIRCUIT BOARDS

Moscow RADIOTEKHNIKA in Russian Vol 37, No 4, Apr 82  
(manuscript received 6 Jul 81) pp 80-82

AGINSKIY, A. L., BOYCHUK, V. N., POBEGAYLO, V. G. and SOSKIN, M. S.

[Abstract] Defects in printed-circuit devices are inhomogeneities, deviations from nominal dimensions, deviations of mechanical, electrical and magnetic parameters from nominal values, emission of stress waves, formation of stress risers and cracks. Inspection is required during the production process, which now drains approximately 20% of the labor force. An optoelectronic television device has been developed, an improvement over earlier ones, which simplifies the inspection procedure and also increases the sensitivity and the resolution. This is achieved by insertion of an amplitude selector into the transmitter-receiver system. The optomechanical module for superposing images accommodates a reference printed-circuit board and the inspected one, which also includes a semitransparent mirror, an objective, a pair of condensor lenses and a light source. The television system consists of a vidicon, a line-sweep generator, a frame-sweep generator, a sync generator, also a video preamplifier, a video amplifier, and the amplitude selector between the two. The video inspection device, coupled to the television system, consists of a kinescope with its video amplifier, line-sweep generator, frame-sweep generator, and a sync pulse selector. As television camera can serve any of the series manufactured KTP-39, KTP-40 or Volna-801 models. Figures 2; references 4: 3 Russian, 1 Western in translation. [260-2415]

SERIES OF CAPACITOR-TYPE MACHINES FOR HERMETIC WELDING OF DEVICES PRODUCED  
BY ELECTRICAL INDUSTRY

Moscow ELEKTROTEKHNIKA in Russian No 5, May 82  
(manuscript received 18 Sep 81) pp 31-33

KOMARCHEV, A. I., candidate of technical sciences, SUVOROVA, G. A., engineer,  
and FEDOROV, P. D., engineer, All-Union Scientific Research Institute of  
Electric Welding Equipment (VNIIESO)

[Abstract] A series of capacitor-type machines for hermetization of the cases of semiconductor devices and integrated microcircuits as well as of power transistors and thyristors during welding is discussed. The series includes semiautomatic PRK-12002 and PRK-4001 with double-pulse discharge from a capacitor bank, as well as MRK-3201 with pneumatic diaphragm-piston drive for longer seams. Each includes a turntable for positioning of parts and a pressurized hood with access door, windows for operators' arms, and gates for feed and discharge of parts. Detailed characteristics of these devices are presented. These machines are already successfully operating in the production of semiconductor devices with TO cases. Figures 5; tables 1; references: 2 Russian.  
[261-2415]

PRODUCTION OF ALUMINUM HEAT SINKS FOR POWER SEMICONDUCTOR DEVICES BY COLD  
WELDING

Moscow ELEKTROTEKHNIKA in Russian No 5, May 82 (manuscript received 18 Sep 81)  
pp 39-41

GROMOV, V. V., candidate of technical sciences, and STROYMAN, I. M.,  
candidate of technical sciences, All-Union Scientific Research Institute  
of Electric Welding Equipment (VNIIESO)

[Abstract] A technology has been developed for producing aluminum heat sinks for semiconductor devices by a cold welding process. A heat sink thus produced consists of a 20 mm thick base made of AD1 aluminum strip and 1-1.5 mm thick corrugated fins made of the same material. The configuration of the assembly, spacing and size of fins, varies depending on the specific application and mode of air cooling: natural or forced. Before the fins are welded on, all parts are cleaned with rotating metal wire brushes. Spot welding of small assemblies is done in a standard P479 hydraulic press, with a special die which consists of a moving plate and a stationary one. Plungers with punches at the tips are mounted on the moving plate, parts to be welded together are placed in the groove of the stationary plate. Seam-spot welding of large assemblies is done in a standard D-2434A hydraulic

press, with appropriately modified plungers-punches which rotate on a shaft while the plate carrying the parts moves horizontally. Prototype heat sink assemblies produced by both variants of this cold welding process have passed mechanical and environmental qualification tests (impact, vibration, humidity, salt spray, fungus, frost). They are comparable with molded ones now produced in the Soviet Union and other countries. Figures 2; tables 3; references: 4 Russian.  
[261-2415]

UDC 621.791.16:[678.5+669]

# STATE OF ART IN ULTRASONIC WELDING OF PLASTICS AND METALS AND OUTLOOK FOR APPLICATIONS OF THIS PROCESS IN ELECTRICAL INDUSTRY

Moscow ELEKTROTEKHNIKA in Russian No 5, May 82  
(manuscript received 18 Sep 81) pp 46-47

KHOLOPOV, Yu. V., candidate of technical sciences, and ZAYTSEV, M. P., candidate of technical sciences, All-Union Scientific Research Institute of Electric Welding Equipment (VNIIESO)

[Abstract] Most significant contributions in the field of ultrasonic welding have been made by scientists at the Moscow Higher Technical School imeni N. E. Bauman under the leadership of Academician G. A. Nikolayev. Machines developed and built for ultrasonic seam welding of plastics include UP-20 (polystyrene), UPT-14 and UPK-15M1 (polyethylene), UPM-12 and UPSh-12 (various polymers and thermoplastic fibercloth). There are 12 models of ultrasonic welding machines in pilot operation in the electrical industry, two general-purpose models already being series manufactured (100 units/year): MTU-0.4-4U4 for welding plastics and metals, MTU-1.5-3U4 for welding plastics. At the same time, special-purpose models are also being developed. Possible applications for ultrasonic welding in the electrical industry are numerous: joining metal foils or wires (copper, aluminum, nickel, steel) in the manufacture of such devices as capacitors, switch blades, grounding terminals, transformers with aluminum windings; joining optical fibers; joining plastics to metals and to ceramics. Ultrasonics can also be used for acceleration of the curing of adhesive compounds and thus can extend the application of adhesives to joining such materials as natural and synthetic leather, the feasibility of which has been demonstrated by the Department of the Footwear Industry at the Leningrad Institute of Textile and Light Industries imeni S. M. Kirov. Ultrasonics can be used for cutting through plasticization and melting away, an effective way to trim raw castings and moldings of excess material.  
[261-2415]

## STATE OF ART IN UNIVERSAL ARC WELDING EQUIPMENT AND OUTLOOK FOR FURTHER DEVELOPMENT

Moscow ELEKTROTEKHNIKA in Russian No 5, May 82 (manuscript received 18 Sep 81)  
pp 7-9

SMIRNOV, V. V., candidate of technical sciences, director of All-Union Scientific Research Institute of Electric Welding Equipment (VNIIESO), and GARBUL', A. F., engineer

[Abstract] An analysis of trends in arc welding techniques reveals that automatic welding with a flux shield is most economical for the construction industry, while semiautomatic welding with a gaseous shield is gradually replacing the manual process in product assembly. Major items contributing to these trends are development of current sources, automation, semiautomation and special-purpose devices. Here the trend is toward modular equipment using standard components. Current sources are available with various means of regulation, most effective being thyristor-transformer sets and inverter-transformer sets. Automation and semiautomation are each designed differently for welding with fusible and refractory electrodes. Welding torch, gear-motor drive and controls are completely coordinated and interchangeable, to cover all user requirements with maximum saving of labor and materials. Incorporation of microcomputers with programmable control will further improve the welding process, particularly the pulse-arc welding technique. One special area of development is an arc revolving in a magnetic field, very effective for welding of pipes, pipes with flanges, and objects with closed-line seams. One such welding machine of the UDK-2201 model is installed at the Orlovsk tractor trailer manufacturing plant, operating with automatic feed and discharge of parts. It replaces 11 operators and saves 50 t of electrode wire annually.

[261-2415]

## MACHINE FOR WELDING CONNECTIONS BETWEEN CELLS IN LEAD-ACID STORAGE BATTERIES

Moscow ELEKTROTEKHNIKA in Russian No 5, May 82 pp 28-29

ZLOBIN, G. I., candidate of technical sciences, and SHIMAREV, V. G., engineer, All-Union Scientific Research Institute of Electric Welding Equipment (VNIIESO)

[Abstract] A welding machine has been developed for making secure solid connections between cells in a lead-acid storage battery. This MTM-70U4 machine consists of three electrodes with a travel regulator each, a conveyor chain, a battery feed mechanism, a battery travel limiter, an electric power supply and control system, a pneumatic drive system, and a cooling system.

It performs the welding operation with a current of 1200 A [Note by abstractor: this may be a misprint for 12 KA] and a pressure force of 1600 N, an extra force of 1400 N being available, with an electrode travel of at least 20 mm. It can handle at least 120 batteries in one hour. Connecting jumpers are welded with adequate sealing and mechanical strength in order to withstand pressures below as well as above atmospheric, and without spattering of lead. With the use of this machine it is possible to make shorter connections and to reduce the amount of lead needed for a battery by 3%. Figures 1; tables 1. [261-2415]

UDC 621.791.752:621.314.21

#### NEW SERIES OF TRANSFORMERS FOR AUTOMATIC FLUX WELDING

Moscow ELEKTROTEKHNIKA in Russian No 5, May 82  
(manuscript received 18 Sep 81) pp 13-16

VORONINA, Ye. A., engineer, ZAKS, M. I., engineer, KAGANSKIY, B. A., engineer, and ROZHKOV, V. P., engineer, All-Union Scientific Research Institute of Electric Welding Equipment (VNIIESO)

[Abstract] A new series of transformers has been developed for automatic flux welding in order to provide a sufficiently high power level and to ensure a stable welding seam. These TDFZh transformers operate by the phase method of regulation, by means of a "contactor" consisting of two thyristors connected in parallel-opposing into the transformer primary. The transformer includes an auxiliary pulse winding between the two secondary coils with a capacitance across it and a reactor coil located in the core window and connected in series-aiding with the primary winding to limit the short-circuit current without affecting the no-load voltage. The TDFZh-2002U3 model has a current rating of 2000 A and operates at a minimum efficiency of 88%. It has class H insulation and is built with a better metal economy (5.6 kg/kW) than all existing series TDF models. It is already series manufactured at Vilnius electric equipment manufacturing plant. Figures 5; tables 1. [261-2415]

## COMPUTERS

UDC [621.311.6:621.397.6]001.57:681.3

### ALGORITHM OF AND PROGRAM FOR FORMING SET OF ACCEPTABLE SUPPLY SYSTEM STRUCTURES FOR RADIOELECTRONIC EQUIPMENT

Kiev TEKHNIЧЕСКАЯ ELEKTRODINAMIKA in Russian No 2, Mar-Apr 82  
(manuscript received 13 Apr 81) pp 44-48

IGNAT'YEV, B. A., Leningrad

[Abstract] Analysis and design of supply systems for radioelectronic equipment have become so complex as to require universally the aid of computers. The main difficulty in formulating and solving optimization problems on the basis of structural and technological data is the impossibility of establishing mathematically rigorous relations between size-mass, energy, electrical and operating characteristics of such systems. Here an algorithm of calculations is proposed which maximizes the available computer capability as well as the utilization of practical experience. It is based on iterative procedure and consists essentially of six steps: 1) The set of acceptable design variants is generated; 2) Preferability (optimality) criteria are established; 3) On the basis of a priori information, scales for evaluating these criteria are constructed and a data bank on interrelations between system quality indicators is built; 4) The acceptable system variants are compared and arranged in order of decreasing preferability, with the aid of those criteria scales and some decision rule; 5) The results of such a lineup are analyzed; and 6) The process is terminated when the results agree with the prescribed requirements and a selection can be made on this basis or, if not, the data on the preferability criteria are refined and the procedure is reiterated from step 3 on. System structures are most conveniently described in the form of directional graphs, as illustrated with a typical supply system which includes a rectifier, a linear or switching stabilizer, and a filter. The algorithm is demonstrated on a two-level supply module serving three users. It has been programmed in FORTRAN-4 for a YeS-1050 "Unified System" computer with a 46 K memory. The machine time required for generating 100 structures is 2 s. Figures 5; references: 8 Russian.  
[257-2415]

# METHOD OF PREDICTING STATE OF RADIOELECTRONIC DEVICES WITH MEMORY COMPONENTS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 25, No 3, Mar 82 (manuscript received 10 Mar 81, after revision 2 Sep 81) pp 89-90

ZHERDEV, N. K., KONDRATENKO, S. S. and LUCHKO, N. I.

[Abstract] A method of predicting the state of radioelectronic devices with memory components is proposed which includes fault location in an integrated circuit and utilizes swings of the supply voltage from nominal down to threshold level. The threshold level serves as generalized parameter. The method is demonstrated on a deterministic case, which predicts the state of a device from which data have actually been taken. The specific example is a shift register consisting of three triggers in series. When all triggers are operative, then a 1 signal will always appear at the fourth output stroke. When the first trigger is faulty, then the timing and the number of triggering events will depend on the location of the triggers. The method is applicable to other memory devices with active elements. In the more usual statistical case prediction of the state requires optimal detection of useful pulse signals submerged in noise and interference. Figures 2; references: 2 Russian. [258-2415]

UDC 621.396.22.029.7:681.7.068.4

# FIBER OPTICS FOR COMMUNICATION LINES IN MINICOMPUTER SYSTEMS

Moscow RADIOTEKHNIKA in Russian Vol 37, No 4, Apr 82 (manuscript received 4 Nov 81) pp 35-40

GORBUNOV, N. M., GRIGOR'YEV, Yu. V., ZHABOTINSKIY, M. Ye., LEVKIN, L. V., NAUMOV, B. N. and SKLEZNEV, A. G.

[Abstract] A special-purpose fiber optical communication line has been developed for use in mini(micro)computer systems. It is built entirely with series manufactured standard components and can be used for two-way communication in any small-computer system built in the Soviet Union and other socialist countries. Its main features are high interference immunity of communication channel and complete galvanic decoupling of object from control computer complex. The line consists of two transceiver modules connected through two single-strand fiber cables. Each module contains an optical transmitter and an optical receiver. Data input to a transmitter and data output from a receiver are effected in code, with zero reset, by standard transistor-transistor logic. The prototype was assembled on a printed-circuit board with necessary shielding. A transmitter consists of a pulse

shaper, a current switch and a light-emitting diode, an AL118 replacing the original smaller AL107B for higher transmission rate (10 Mbit/s), both rise time and fall time of light pulses being controlled by that switch, and power stability over the 5-55°C temperature range being achieved by parametric compensation. A receiver consists of an FPZ-3 light-activated diode, a pre-amplifier (KP303G, KT363B, KT368A low-noise transistors), a main amplifier (K544UD2B integrated-circuit low-noise operational amplifier stages), a comparator and a pulse shaper. The optical cables are made of "Gradan" glass fiber, 60 micrometer in diameter with numerical aperture 0.17 and attenuation of 4-8 dB/km. Maximum permissible total loss in cable is 15-20 dB, which corresponds to 2.5-3 km cable length. The device was tested in a SM-4 computer system with peripheral equipment consisting of an SM-7206 alphanumeric video terminal, adapter links, a DZM high-speed printer and magnetic input-output disks. It was tested in the multiple-access dialog mode operation with time sharing, according to the "DIAMS" program. Figures 6; references 4: 3 Russian, 1 Western in translation. [260-2415]

UDC 681.3

#### CONVEYOR-TYPE MULTIFUNCTIONAL COMPUTER ARRAYS

Leningrad IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 25, No 4, Apr 82 (manuscript received 21 Apr 81) pp 48-52

AL'KHOVIK, A. S. and BAYKOV, V. D., Leningrad Institute of Electrical Engineering men V. I. Ul'yanov (Lenin)

[Abstract] Conveyor-type and asynchronous computer arrays are compared with respect to hardware cost, speed and multifunctionality. As quality criterion serves the compatibility factor, which varies from 0 to 1 and depends on the algorithms of multifunctional computer operations. While the speed of an asynchronous array does not depend on the data volume, conveyor type arrays will be faster, at higher cost, when the data volume is large. Here cost and compatibility are evaluated, as functions of the word length and with delay time per computer tier taken into account, for two conveyor-type computer arrays: one performing basic arithmetic operations (multiplication, division, squaring and square-root extraction), one evaluating elementary functions (including trigonometric, hyperbolic, exponential and logarithmic) by the "digit after digit" method. While the hardware cost increases more than linearly with increasing word length, the compatibility factor first increases linearly and then levels off. Algorithms of the "digit after digit" method ensure maximum compatibility, making it possible to reduce the cost of attaining high speed. The paper was recommended by the Department (Kafedra) of Computer Techniques. Figures 3; references 2: 1 Russian, 1 Western. [265-2415]

## EVALUATION OF Q-FUNCTION WITH AID OF 'ELEKTRONIKA B3-21' CALCULATOR

Moscow RADIOTEKHNIKA in Russian Vol 37, No 4, Apr 82  
(manuscript received 29 Jun 81) pp 61-62

FINK, L. M.

[Abstract] The existing program for evaluating the Markum Q-function

$$Q(x, y) = \int_y^{\infty} e^{-\frac{(x^2 + y^2)}{2}} I_0(yx) dx \quad (x, y \geq 0)$$

with the aid of an "Elektronika B3-21" programmable calculator is very inefficient at low values of the argument. Another program

$$Q(x, y) = e^{-\frac{(x^2 + y^2)}{2}} \sum_{n=0}^{\infty} \frac{(x^2/2)^n}{n!} \sum_{k=0}^n \frac{(y^2/2)^k}{k!}$$

based on series expansion of the modified Bessel function  $I_0(yx)$  and subsequent term-by-term integration, requires much less time: maximum 30 min, without overloading till  $x^2 + y^2 > 450$ , only 35 s when  $x = 0.5$  and  $y = 1$ . Tables 1; references: 1 Russian. [260-2415]

UDC 681.325.36

## HIGH-SPEED GENERATOR OF RANDOM NUMBERS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY; RADIOELEKTRONIKA in Russian Vol 25, No 4, Apr 82 (manuscript received 10 Nov 81) pp 90-92

DONOV, G. I.

[Abstract] A generator of random numbers is described which consists of a shift register with trinomial  $x^n + x^k + 1$  feedback connection between stages. It generates maximum-length sequences of  $m$ -digit binary numbers with almost all characteristics of random and pseudorandom sequences. The repetition period  $M = 2^n - 1$  of pseudorandom sequences can be made arbitrarily long, in order to approach a random sequence, by increasing the length of  $n$  of the shift register. The speed of the generator can be increased by changing the original series connection of register stages to a parallel one so that the same sequences will be generated but more of them at a time. This scheme is theoretically demonstrated on a simple generator with a 4-digit shift register and a mod 2 adder in the feedback circuit. The scheme was

tested by a statistical experiment, in a BESM-6 high-speed computer, with a 47-digit shift register and  $x^{47} + x^5 + 1$  feedback. Not only mean and mean-square values were computed but also  $10^6$  triads of generated random numbers were checked by sorting into 1000 boxes, depending on which of the 10 equal parts of the (0,1) interval each variable belonged. The probabilities of each triad falling into any one of the boxes were equal, according to the chi-square criterion, indicating an adequate degree of randomness. Figures 2; tables 2; references: 4 Russian. [262-2415]

#### JOSEPHSON EFFECT IN COMPUTER ENGINEERING

Moscow RADIO in Russian No 2, Feb 82 pp 15-16a

LIKHAREV, K., doctor of physical and mathematical sciences

[Abstract] The computers which will appear in 10 to 15 years will have capacities of 100 million instructions per second (MIPS) and nanosecond access times, requiring that they be very compact to minimize signal transmission time delays. This will require great reductions in power consumption per component to reduce heat dissipation problems. The Josephson effect and Josephson junction, which take advantage of the coherent motion of charge carriers in superconductors, are seen as major means of achieving the sort of high speed, low energy devices which will be required. Color diagrams are used to explain the operation of a Josephson junction. It is predicted that computers operating at liquid helium temperatures will achieve speeds of over 200 MIPS within the next 10 to 15 years. A hypothetical "conveyor" computer consisting of  $10^9$  Josephson-junction-based elements could process information at  $10^{20}$  bits per second while consuming 10 watts of power. Figures 10. [205-6508]

## ELECTRICAL INSULATION

UDC (621.315.616:621.313).002.2

### OPTIMUM TECHNOLOGICAL PARAMETERS FOR PRODUCING NEW ELASTOMER MATERIAL AND INSULATION BASED ON IT

Moscow ELEKTROTEKHNIKA in Russian No 4, Apr 82  
(manuscript received 18 Dec 80) pp 48-50

TALYKOV, V. A., candidate of technical sciences, ANISIMOVA, Ye. K., engineer, IL'INA, O. M., engineer, PETRASHKO, Yu. K., candidate of technical sciences, and CHERNICHKINA, A. S., candidate of technical sciences, All-Union Scientific Research Institute of Electrical Insulation Materials

[Abstract] A new electrical insulation material for 180°C has been developed at the All-Union Scientific Research Institute of Electrical Insulation Materials and Dielectric Foils. It consists of SKTN-A silicone rubber (caoutchouc) as binder without solvent, glass-cloth reinforcement and mica paper as filler. It is producible in the form of tape, has excellent technological characteristics and dielectric properties, also retains its elastic properties during thermal aging at 220 or 240°C. A study was made of the hardening processes in the binder and in the glass cloth upon impregnation with K-33 lubricant with cold-vulcanization catalysts. The temperature dependence of the electrical conductivity, the dielectric permittivity and the loss tangent was measured during the hardening process. The results reveal two stages, first catalytic polymerization and then gelation after 10-12 days at room temperature already. This process accelerates with rising temperature and becomes most intense within the 120-160°C range. Structurization with a change in the electrical properties occurs within the 250-290°C temperature range. The catalysts advance the beginning of both gelation and structurization. Tape of this material is recommended for winding stators and rotors of low-voltage machines, including those with moisture-proof construction. Figures 6; references: 2 Russian.  
[207-2415]

## ELECTROMAGNETIC COMPATIBILITY

UDC 621.313.12.001.24

### CALCULATION OF ELECTROMAGNETIC FIELD AND PARAMETERS OF SHIELDED END TURNS OF SINGLE-PHASE SHOCK GENERATOR

Moscow ELEKTRICHESTVO in Russian No 8, Aug 81  
(manuscript received 15 Aug 80) pp 22-26

KUTAREV, A. M., Orenburg Polytechnical Institute, SIPAYLOV, G. A. and  
KHOR'KOV, K. A., Tomsk Polytechnical Institute

[Abstract] This paper is concerned with establishing the best constructive fulfillment of the end zone of a single-phase shock generator. An account is given of a calculation algorithm for a quasi-stationary magnetic field in the region of the end turns of a single phase shock generator based separately on determination of the current with respect to the electrical field intensity in the bulk of each current-conducting medium. It is shown that during fulfillment of the end turns of the stator winding of a shock generator with bends at a  $90^\circ$  angle, the current conducting shields must overlap all the face surface of the stator up to the interior surface of the generator housing. The degree of reduction of the electrodynamic force because of the damping effect of shields is different when the end turns are fulfilled without a bend and with a bend at a  $90^\circ$  angle. Losses in cylindrical shields of non-bend end turns are substantially lower in shields with fulfillment of the end turns with a bend at a  $90^\circ$  angle. The recommendations made in the present work conform with the practice of fulfillment of the end turns of type TI generators produced by the "Elektrosil" plant. Experimental investigations made on models of the end-type shock generators confirm the theoretical. Figures 5; references 12: 9 Russian, 3 Western. [87-6415]

UDC 535.317.2

COMPENSATION OF ERRORS IN OPTICAL SCANNING SYSTEMS

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE  
in Russian Vol 25, No 5, May 82 (manuscript received 16 Dec 80) pp 23-26

GALUYEV, S. V., MIKHEYEV, V. P. and ROZOV, B. S., Moscow Institute of  
Engineering Physics

[Abstract] A method of error correction in optico-mechanical scanning systems with discrete displacement transducers is proposed which not only does not decrease but even increases the speed. It involves optical correction with aid of an additional deflector for stabilizing the scanner mirror through suppression of self-excited oscillations. An "inertialess" deflector as well as a magnetoelectric or piezoelectric one can be used. The efficiency of such a device in following the logic of scanner control is measured by the error dispersion. An acoustooptic deflector on a  $\text{TeO}_2$  single crystal with a time constant of  $10^{-5}$  s tolerates amplitudes of self-excited oscillations as large as 27 scale units and allows the system speed to be quintupled. The paper was recommended by the Department (Kafedra) of Automation and Telemechanics. Figures 1; references 4; 3 Russian, 1 Western (in translation).  
[263-2415]

UDC 621.316.543:621.382.233.001.4

ESTIMATING EFFECTIVENESS OF HIGH-VOLTAGE THYRISTORS AS TRANSFORMER VOLTAGE REGULATORS

Moscow ELEKTROTEKHNIKA in Russian No 4, Apr 82  
(manuscript received 23 Jun 81) pp 34-36

GUREVICH, V.I., engineer, Khar'kov Institute of Agriculture Mechanization and Electrification

[Abstract] The effectiveness of thyristors as transformer voltage regulators is estimated on the basis of a composite indicator, namely the sum of  $n$  performance and design indicators (reliability, mass, size, etc), each with a weight factor, divided by the cost. This composite indicator can have an

extremum, which corresponds to the optimum under technical constraints such as discreteness of the partial indicators. The procedure is shown for calculating, on this basis, the cost function of a complex system such as a multithyristor voltage regulator referred to its current loading and voltage margin during stable commutation. The procedure is demonstrated on examples of a smooth regulator and a discrete one. The former is used preferentially in rural power distribution networks, but the latter is found to become more cost effective at 35 kV and higher voltages. Modifications of a discrete transformer voltage regulator have been developed at the Khar'kov Institute of Farm Mechanization and Electrification which should cost less than approximately 7,000 rubles. One of them involves successive triggering of thyristor groups and includes protective diodes. Figures 2; references: 9 Russian. [207-2415]

UDC 621.382.3.027.262.2.263.8

#### HIGH-VOLTAGE POWER TRANSISTOR

Moscow ELEKTROTEKHNIKA in Russian No 3, Mar 82  
(manuscript received 10 Dec 81) pp 29-30

BUDISHEVSKIY, Yu. D., engineer, DUCHENKO, Yu. V. engineer, ZAKHAROV, Yu. V., engineer, SIDORENKO, Yu. P., engineer, and STREZH, A. A., engineer,  
Molodechno Plant for Semiconductor Power Rectifiers

[Abstract] A series of high-voltage transistors has been developed for maximum collector-base voltages of 400-800 V, maximum collector-emitter voltages of 250-600 V, and collector currents up to 40 A. They have a  $n^+p-n-n^+$  structure with a high-resistivity collector and are produced by unilateral diffusion into epitaxial structures. The p-n emitter junction is produced by two-stage diffusion of phosphorus from the gaseous phase with  $PCl_3$  as diffusant. Contact regions are bared by photolithography and the transistor structure is completed by metallizing, mesa etching and scribing, whereupon the crystals are assembled in TO-3 housing with leads up. The minimum steady-state common-emitter forward-current gain of these devices is 8, at a collector-emitter voltage of 5 V and a collector current equal to half the maximum permissible collector pulse current. Figures 3; tables 1; references 5: 1 Russian, 4 Western. [253-2415]

## PROFILING, PASSIVATION AND PROTECTION OF COLLECTOR JUNCTION SURFACES FOR HIGH-VOLTAGE TRANSISTORS

Moscow ELEKTROTEKHNIKA in Russian No 3, Mar 82  
(manuscript received 3 Aug 81) pp 12-15

KUUZIK, E. I., engineer, and KYVERIK, K, Kh., engineer, Scientific Research Institute at Tallinn Electrotechnical Plant imeni M. I. Kalinin

[Abstract] Modern methods used for producing high-voltage power transistors include profiling the collector junction surfaces by depletion etch or planar junction etch, doping the semiinsulating polycrystalline silicon film with oxygen or using such SIPOS process film in a four-layer SIPOS-SiO<sub>2</sub>-glass-SiO<sub>2</sub> coating for passivation. Various resin compounds are also available for surface protection. The choice of process and material depends on the voltage rating and the operating temperature, also on the collector current and thus the size of the collector area. Figures 4; tables 1; references 15: 2 Russian, 13 nonRussian.  
[253-2415]

## HIGH-CURRENT POWER TRANSISTORS

Moscow ELEKTROTEKHNIKA in Russian No 3, Mar 82  
(manuscript received 2 Nov 81) pp 9-11

SHABOYAN, S. A., candidate of physico-mathematical sciences, Special Design and Technological Office of Semiconductor Engineering

[Abstract] Series TK bipolar high-current power transistors with an n<sup>+</sup>-p-n<sup>-</sup>-n<sup>+</sup> structure and a comb topology are produced by planar technology involving double or triple unilateral diffusion of emitter and base impurities into n<sup>+</sup>-n silicon slices which have been grown epitaxially or by "counter-diffusion" with subsequent grinding and polishing of active surfaces. The breakdown voltage depends on both the thickness and the electrical resistivity of the collector n<sup>-</sup>-layer, increasing with both, but it falls below theoretical levels as the area of the transistor structure becomes larger. These three design parameters thus determine the peak inverse voltage rating. Existing devices are rated for 200-250 V only, but new ones have been designed for voltages of 400-600 V and collector currents of 16-100 A. This capability is achieved by optimization of the emitter structure, controlling the current distribution in the high-resistivity collector region and thus controlling the saturation resistance of the transistor, then appropriately applying the metallization process. The housings are of two basic constructions. Figures 5; tables 1; references: 2 Russian.  
[253-2415]

## INSTRUMENTATION & MEASUREMENT

UDC 535.4:621.38

### REVEALING IMPURITY NONHOMOGENEITY IN SEMICONDUCTOR SINGLE CRYSTALS BY METHOD OF INTERFEROMETER MICROSCOPY

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 4, Apr 82 pp 38-39

RONDAREV, V. S.

[Abstract] An experimental study was made in order to establish the feasibility of revealing nonhomogeneity due to nonuniform distribution of doping impurities in crystals by the method of interferometer microscopy, without depositing additional reflective films on the specimen and without use of external interferometers. Interferograms were produced with the aid of a laser-television infrared microscope ( $\lambda = 1.15$  micrometer). Specimens of 300 micrometer thickness were cut from electron-grade GaAs crystals which had been pulled by the Czochralski method, doped with tellurium ( $n_e = 6 \cdot 10^{17} - 2 \cdot 10^{18} \text{ cm}^{-3}$ ), and polished mechanically. Control measurements of the concentration profile were made by the absorption method at the 10.6 micrometer wavelength and chemical etching. The method of interferometer microscopy was found to extend the scope of measurements, specifically in determination of thickness uniformity, but also to have a definite systematic error due to large variance of the refractive index. References: 6 Russian, [259-2415]

UDC: 535.22:543.47

### POLARIMETRIC METHOD OF DETERMINING SPECTRAL RADIATION COEFFICIENTS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 3, Mar 82 (manuscript received 4 Feb 81) pp 1-3

AKSYUTOV, L. N.

[Abstract] Certain rather simple relationships which follow from the Fresnel-Koenig equations allow relative measurements of the angular variation of the spectral brightness density of radiation p and s components to be used

in order to determine the optical characteristics of adsorbing materials. In spite of the apparent simplicity of this method, the need to perform measurements at two angles complicates measurement apparatus and the process. This article suggests a polarimetric method allowing the normal value of spectral radiation coefficient to be determined on the basis of measurements of the polarization of natural radiation at one fixed angle to the surface. Values obtained by a single reading at a radiation angle of  $50^\circ$  are compared with experimental values obtained by the black body method and found to be reliable. Figures 1; tables 3; references 8: 6 Russian, 2 Western.  
[208-6508]

UDC 6]1.318.134.029.64

#### SPECTRUM OF EXCHANGE AND NONEXCHANGE SPIN WAVE EXCITATIONS IN FERRITE-GARNET FILMS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 3, Mar 82  
(manuscript received 11 Aug 80) pp 518-524

LUGOVSKOY, A. V. and SHCHEGLOV, V. I.

[Abstract] An experimental study was made of the excitation spectra of exchange and nonexchange spin waves in thin garnet and ferrite-garnet films, with varying orientation of the external magnetic field. Films of iron-yttrium garnet and of ferrite-garnet mixture ( $Y_{1.3}Gd_{1.7}Yb_{0.7}Ga_{0.9}Fe_{4.4}O_{12}$ ) were grown by the liquid-phase epitaxial process to a thickness not exceeding 4-5 micrometer. Measurements were made with resonance spectrometers at frequencies of 1.2 and 9.2 GHz over the 0-5000 Oe range of magnetic field intensity. The parameters of both uniaxial and cubic anisotropy as well as of shape and surface anisotropy were determined. The results reveal also a strongly anisotropic first derivative of resonant absorption with respect to the orientation angle of the magnetic field, and an anomalous "mirror" precession of resonances in garnet films with the axis of anisotropy parallel to the plane of the film. The authors thank P. Ye. Zil'berman, F. V. Lisovskiy, V. I. Zubkov and A. V. Vashkovskiy for discussion and helpful comments, also B. P. Nam, A. G. Konovalov and I. G. Avayeva for supplying the specimens. Figures 4; references 21: 14 Russian, 7 Western (1 in translation).  
[206-2415]

## REDUCING PHASE ERROR OF MEASURING CIRCUIT BY METHOD OF FREQUENCY SPECTRUM TRANSPOSITION

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 4, Apr 82 pp 48-51

GRINBERG, I. P.

[Abstract] The method of frequency spectrum transposition is applied to linearization, with minimum error, of the phase-frequency characteristic of a measuring device. This requires that the characteristic be first approximated with a broken line. The output signal from the measuring device is sent to a corrective system consisting of several channels, each cutting a frequency spectrum from the input signal which corresponds to the given segment of the broken line and transposing it to the low-frequency range or high-frequency range prior to sending it to the corrective circuit. The latter effects, with respect to the output signal, a reverse transposition of the frequency spectrum into its "own" subrange. The output voltages from all corrective channels are added. A heterodyne frequency must be selected and the system components tuned accordingly for minimization of the phase swing time. When this frequency is selected above the upper cutoff frequency of the signal spectrum, and a filter which passes difference frequencies is placed at the multiplier output, then "inversion" of the spectrum can occur and either full or partial compensation is required. Phase shifts introduced by the corrective circuit and having opposite signs can serve this purpose. Figures 2; references: 2 Russian, [259-2415]

## ACCURACY OF MEASURING WIDTH OF SPECTRUM OF WIDEBAND RADIO SIGNALS IN AMBIENT INTERFERENCE IN OPTOACOUSTIC SPECTRUM ANALYZER

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY; RADIOELEKTRONIKA in Russian Vol 25, No 4, Apr 82 (manuscript received 23 Jun 81) pp 62-69

GUREVICH, A. S. and NAKHMANSON, G. S.

[Abstract] An optoacoustic spectrum analyzer is considered for measuring the spectral width of a radio pulse appearing with additive normal random interference and in ambient noise. The instrument consists of a monochromatic light source, condenser, plane-wave collimator, ultrasonic light modulator, Fourier-transform lens, and optoelectronic processor (linear matrix of  $n$  photoreceivers, each followed by an amplifier and a threshold device). The accuracy of such a measurement is estimated, taking into account intrinsic noise in the optoelectronic system. Calculations are shown for a mixture of a short rectangular radio pulse propagating faster than ultrasound through the modulator and a wideband normal random interference with rectangular

spectral density distribution, both in ambient white noise. The dispersion of the estimate of spectrum width is found to increase with increasing number of illuminated photoreceivers and thus with decreasing duration of signals. As the duration of the radio pulse decreases, the light energy interacting with the signal in the modulator also decreases so that the signal-to-noise ratio at the output and thus also the accuracy of measurement decrease. Conditions for maximum accuracy and minimum dispersion are established on the basis of the given data. Figures 5; references: 7 Russian.  
[262-2415]

UDC 681.7:535.4

#### MULTICHANNEL POLARIZATION INTERFEROMETERS

Moscow IZMERITEL'NAYA TEKNIKA in Russian No 4, Apr 82 pp 28-33

ZASTROGIN, Yu. F.

[Abstract] In multichannel interferometers the optical signals are either normally incident in both reference and measuring arms or incident at different angles in each. In the latter case the frequency modulation index is varied, and, consequently the measurement range can be varied. The optical part of a multichannel polarization interferometer of the first kind includes a light source, a light splitter ( $n$  beams: one reference,  $n-1$  measuring),  $n-1$  optoelectric converters consisting each of an  $\text{LiNbO}_3$  crystal between two quarter-wave plates,  $n$  divider cubes,  $n+1$  polarizers, and a photoreceiver. Electric output signals from the photoreceiver are transmitted through band filters and frequency detectors to measuring instruments. The optical part of a multichannel polarization interferometer of the second kind is more intricate, with beam splitting, dividing, and branching. It has two photoreceiver channels, each with a polarizer and a condensor lens. Electric output signals from one are transmitted through narrow-band filters to calibrating instruments, those from the other are transmitted through narrow-band filters and frequency detectors to amplitude measuring instruments. The measuring process is in each case described by the corresponding matrix equations for signals through successive instrument components. Measurement of torsional vibrations is demonstrated on a two-channel polarization interferometer of each kind with a scanning device. Figures 3; references: 3 Russian.  
[259-2415]

UDC 621.3.032.217

MECHANISM OF PHOTOEMISSION FROM Ag-O-Cs PHOTOCATHODE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 3, Mar 82  
(manuscript received 1 Dec 80) pp 586-591

GUGEL', B. M., KRUPENINA, A. Ya., MELAMID, A. Ye. and STEPANOV, B.MM.

[Abstract] A study of Ag-O-Cs photocathodes was made by the degradation method in a specially built photocell. A photocathode was divided into three segments: left-middle-right. The left-hand segment was illuminated first from an incandescent lamp through a red filter passing a continuous spectrum of  $\lambda > 0.74$  micrometer wavelengths and then from a high-pressure mercury-arc lamp through a filter blocking the spectrum of  $\lambda > 0.5$  micrometer wavelengths. The degradation of both middle and right-hand segments was measured in terms of integral sensitivity and spectral distribution of photoemission yield. On the basis of these data and assuming a square-law dependence of photoemission yield on the difference between light quantum energy and work function of the photocathode material, the coefficient in this relation being determined by the processes in the photocathode bulk, the mechanism of photoemission and degradation is interpreted as being associated with absorption of light by free charge carriers in colloidal silver particles and changes in the concentration of free electrons in the  $\text{Cs}_2\text{O}+\text{Cs}_2\text{O}_2$  matrix. The extent of long-wave sensitivity is determined by the work function of the photocathode material only, while excited electrons pass through the Helmholtz-Stern double layer into the conduction band of cesium oxides almost without loss. Figures 4; tables 2; references 13: 9 Russian, 4 Western.  
[206-2415]

## SPECIAL ASPECTS OF THERMAL COMPUTATION OF RECTIFIERS UNDER EMERGENCY CONDITIONS

Moscow ELEKTRICHESTVO in Russian No 8, Aug 81  
(manuscript received 21 Jul 80) pp 16-21

STAROVEROV, G. M., candidate of technical sciences, and IVANOV, G. V.,  
engineer, Noril'sk

[Abstract] As is known, thermal calculations of semiconductor devices are made with various simplifications and assumptions. It is possible to divide these assumptions and the errors of calculation corresponding them into three categories: 1) Approximated determination of the power (energy), separable in the device because of the substitution of instantaneous values of the current and voltage by average parameters; 2) Simplification of the thermo-physical model of the device and approximate determination of its parameters; and 3) Withdrawal from real time of the heat release process in the device. The authors take these factors into consideration, which, as compared with methods used at the present time, substantially changes the calculating pattern. Recommendations are made with respect to thermal calculation of rectifiers under emergency conditions. An experimental check of the method is described. Figures 2; tables 1; references: 7 Russian.  
[87-6415]

## UPPER FREQUENCY LIMIT OF GUNN EFFECT IN GALLIUM ARSENIDE

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 15, No 12,  
Dec 81 (manuscript received 9 Feb 81) pp 2309-2313

KAL'FA, A. A., PORESH, S. B. and TAGER, A. S.

[Abstract] The upper frequency limit of the Gunn effect in gallium arsenide is calculated on the basis of the two-temperature model, considering that in a rapidly varying electric field the heating of electrons in the lower valley occurs primarily as a result of ballistic acceleration along the free path. In connection with this the optimum structure of a Gunn-effect diode with the highest possible frequency of transit modes is also determined. The theoretical concepts have been verified by calculations for a GaAs device with an  $n^+-n-n^+$  structure and a high dopant concentration, connected into an electric circuit with a parallel resistance-inductance combination. With a constant voltage above some threshold across the diode, self-excited oscillations built up in the electric circuit at a frequency controllable through regulation of the inductance. The results indicate that the conventional approximation of a uniform field and a harmonic signal does not yield the true upper

frequency limit, that the frequency characteristics of a Gunn-effect diode depend on its structure, and that diodes not uniformly doped but with a strongly nonuniform cathode region have the highest frequency limit. A diode with a  $1 \cdot 10^{-5} \text{ cm}^2$  active area delivering 5 mW at 232 GHz with 0.14% efficiency is feasible, the intervalley transit time corresponding to a 600 GHz frequency. The authors thank G. L. Gurevich for helpful discussions and A. V. Garmatin for calculating the upper frequency limit in the uniform-field approximation on the basis of the two-temperature model. Figures 1; references 10: 5 Russian, 5 Western.  
[185-2415]

UDC 621.315.592

# METAL-SEMICONDUCTOR JUNCTION IN n-GaAs IN STRONG MAGNETIC FIELDS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 15, No 12, Dec 81  
(manuscript received 2 Mar 81) pp 2333-2338

MATVEYEV, G. A., Institute of Metal Physics, Ural Science Center, USSR Academy of Sciences, Sverdlovsk

[Abstract] An experimental study was made of conduction mechanisms near the metal-semiconductor junction in epitaxial and bulk n-GaAs layers at temperatures of 1.8-4.2 K in a magnetic field, specimens of this material having been doped with fine donor impurity to  $n = (3-5.4) \cdot 10^{16} \text{ cm}^{-3}$ . The magnetic field was applied in pulses of 5.5-100 ms duration. The magnetoresistivity and the Hall coefficient were measured over the 0-350 kG range of magnetic induction. The degree of compensation in the specimens was determined from conduction measurements at zero magnetic induction and the Hall coefficient at 77 K in a magnetic field with 10 kG magnetic induction. There was found no significant distinction between the magnitudes and the field dependence of longitudinal and transverse magnetoresistivity. With increasing magnetic induction, the metallic mode of conduction was found to remain unchanged until the critical magnetic induction had been reached and then to depend on the temperature, this critical magnetic induction within the 45-75 kG range depending on the electron concentration. Peaking of the magnetoresistivity at the critical magnetic induction and its subsequent anomalous decrease with further increasing magnetic induction indicates an impurity mode of conduction. Both the magnetoresistivity and the Hall coefficient were found to exhibit hysteresis in a first increasing and then decreasing magnetic field, with the Hall coefficient peaking within the 25-40 kG range. The authors thank I. M. Tsidil'kovskiy for steady interest in the study and valuable comments, as well as R. V. Pomortsev and N. G. Shelushinina for discussing the results. Figures 4; tables 1; references 22: 8 Russian, 14 Western.  
[185-2415]

PHOTOELECTRICAL PROPERTIES OF  $\text{CdSnAs}_2$ 

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 15, No 12, Dec 81  
(manuscript received 3 Feb 81, final version 19 Mar 81) pp 2357-2361

DOVLETMURADOV, Ch., LEBEDEV, A. A., RUD', Yu. V., SERGINOV, M. and  
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[Abstract] The photosensitivity spectra of  $\text{CdSnAs}_2$  single crystals with chalcopyrite lattice and n-p homojunction were measured in natural light over the 0.2-2.5 eV range at 77 and 300 K temperatures. The specimens were produced by zonal recrystallization of specially undoped n-type and p-type crystals with free charge concentration of  $(0.5-5) \cdot 10^{18} \text{ cm}^{-3}$  and arbitrary crystallographic orientation. The homojunctions were produced by natural doping (controlled annealing) and impurity doping (diffusion of copper). The current-voltage characteristic of such an n-p junction was measured along with the photoconduction spectrum of a p- $\text{CdSnAs}_2$  single crystal and the photosensitivity spectrum of a diode structure. The results indicate that  $\text{CdSnAs}_2$  single crystals are suitable for use as either selective or wideband photodetectors of long-wave natural radiation. Figures 3; references 10: 6 Russian, 4 Western.

[185-2415]

## RADIATIVE DEFECTS IN SILICON BOMBARDED BY 20 MeV PROTONS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 15, No 12,  
Dec 81 (manuscript received 15 Dec 80, final version 19 Mar 81) pp 2352-2356

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[Abstract] Characteristics of radiative defects in silicon with initial electrical resistivity of 0.3 ohm.cm caused by bombardment by 20 MeV protons with flux density of  $10^{14} \text{ cm}^{-2}$  were studied experimentally by the methods of thermally stimulated capacitance and photocapacitance. The temperature dependence of thermal ionization (electron emission) rate and the photocapacitance spectrum were measured by the compensation method over the 77-300 K temperature range, at 150 kHz frequency and 10 V reverse voltage. The results are interpreted in terms of optical and electron transitions in the energy band structure as well as theoretical spectrum of cross section for photon capture. They indicate formation of three acceptor levels ( $E_c - 0.17$ ,  $E_c - 0.31$ ,  $E_c - 0.46 \text{ eV}$ ) and one donor level ( $E_v + 0.32 \text{ eV}$ ) in n-type silicon under such a bombardment. Figures 3; tables 1; references 24: 15 Russian, 9 Western.

[185-2415]

## CHARACTERISTICS OF PROCESS OF ENERGY LOSS BY EXCESS CARRIERS IN STRONGLY DOPED SEMICONDUCTORS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 15, No 12,  
Dec 81 (manuscript received 11 Feb 81, final version 20 Apr 81) pp 2378-2383

LIBENSON, B. N. and STUCHINSKIY, G. B.

[Abstract] The process of energy loss by hot excess carriers in strongly doped semiconductors is analyzed, taking into account the "low-frequency" plasmon mechanism of scattering. Calculations are based on the equation of power loss in a medium describable by the polarization operator. The latter, regardless of the degree of degeneracy, characterizes pairwise collisions with equilibrium carriers at the short-wave extreme and electron-electron scattering with anisotropy of plasma frequencies at the long-wave extreme. The rate of energy loss has been determined for an electron on an isoenergetic surface in the conduction band near its minimum and displaced from the center of the Brillouin zone. It is estimated numerically, as a function of electron energy, for n-Ge and p-GaP crystals, the latter with an isotropic effective mass of holes in the valence band. The authors thank V. V. Rumyantsev for helpful discussions. Figures 2; references 11; 9 Russian, 2 Western. [185-2415]

THEORY OF  $\text{Cd}_x\text{Hg}_{1-x}\text{Te}$  THRESHOLD PHOTORESISTORS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 15, No 12,  
Dec 81 (manuscript received 29 Aug 80, final version 4 May 81) pp 2384-2391

DRUGOVA, A. A. and OSIPOV, V. V.

[Abstract] The detectivity of threshold photoreceivers and the blip-mode detection (limited to background infrared radiation noise) temperature are determined analytically for perfect  $\text{Cd}_x\text{Hg}_{1-x}\text{Te}$  photoresistor crystals with flicker noise and defective crystals also with generation-recombination noise caused by fluctuation of the electron concentration and Nyquist noise. The dependence of detectivity on concentration of majority carriers and the temperature dependence of detectivity corresponding to either radiative recombination or Auger recombination are determined on the basis of appropriate relations for the respective recombination time and for the charge carrier concentration, with the energy gap as a function of temperature  $T$  and cadmium content  $x$  described by the expression  $E_g(x, T) = 1.59x - 0.25 + 5.233 \cdot 10^{-4}(1 - 2.08x)T + 0.327x^3$  eV. Numerical data have been obtained for  $x = 0.2 \pm 0.05$ , on the assumption that the effective hole mass is  $m_h = 0.71m_0$  (independent of  $x$  and  $T$ ) and the effective electron mass is  $m_e = 0.07055E_g^{m_0}$ . The authors

thank L. A. Bovina, L. N. Neustroyev and V. I. Stafeyev for stimulating discussions. Figures 3; references 32: 15 Russian, 17 Western. [185-2415]

UDC 621.315.592

#### PHOTOELECTRICAL PROPERTIES OF GaAs/ZnSe HETEROSTRUCTURES

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 15, No 12, Dec 81 (manuscript received 16 Sep 80, final version 18 May 81) pp 2392-2395

DEMCHENKO, A. M., Industrial Plant for Pure Metals imeni Semicentennial of USSR, Svetlovodsk

[Abstract] The photoelectrical properties of GaAs/ZnSe heterostructures were studied for the purpose of determining the suitability of ZnSe and its solid solutions in GaAs as a re-emitting layer with high quantum yield. Specimens of these heterostructures were grown by chemical reactions in the gaseous phase, with 3-5 micrometer thick ZnSe layers deposited on n-GaAs substrates with  $n_e = (5-8) \cdot 10^{17} \text{ cm}^{-3}$  and (100) orientation. Diffusion of zinc into GaAs produced a p-n homojunction 2-4 micrometer away from the GaAs-ZnSe interface. Such a heterostructure was ground on one side down to a hetero-epitaxial ZnSe layer on the GaAs substrate. Into the n-region were fused in In + 3% Ni contact tabs, into the p-region were fused in In + 3% Ni + 2% Zn contact tabs at spots where ZnSe had been etched away. Specimens with high emission yield (3.0-3.5%) and with low emission yield (0.3-1.0%) were obtained, the quantum emission being measured with an FD7K silicon photodiode under excitation by monochromatic  $\lambda = 0.44$  micrometer light at room temperature. The photosensitivity spectra of both kinds of heterostructures were measured and compared, 0.92-0.94 micrometer being the long-wave edge in each case. The luminescence excitation spectra of their wideband region as well as the photoluminescence spectra of their various other regions, including the narrow-band region, and the electroluminescence spectra were also measured. According to the data, heteroepitaxial ZnSe layers on GaAs substrates can be used in heterophotocells with intermediate radiation conversion. The author thanks F. P. Kesamanly for formulating the objectives of this study and for helpful suggestions, as well as P. N. Tkachuk for assistance in preparation of the specimens. Figures 2; references 11: 7 Russian, 4 Western. [185-2415]

## CURRENT-VOLTAGE CHARACTERISTICS OF NONHOMOGENEOUS ANISOTROPIC SEMICONDUCTORS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 15, No 12, Dec 81  
(manuscript received 16 Apr 81) pp 2419-2420

KORNYUSHIN, Yu. V., Institute of Metal Physics, UkSSR Academy of Sciences,  
Kiev

[Abstract] Current-voltage characteristics are determined for unipolar anisotropic semiconductor devices nonhomogeneous in the direction perpendicular to the applied electric field, such semiconductor structures consisting of parallel layers with unequal carrier mobilities but equal carrier concentrations. Calculations are based on a mobility tensor varying along the coordinate perpendicular to the direction of current flow. The general equations are applied to thin plates, of thickness much smaller than the Debye shielding radius, and to a plate consisting of two different homogeneous layers. The current-voltage characteristics are strongly nonlinear and, as one numerical example demonstrates, can have a pronounced N-form range when the ratio of carrier mobilities in the two nonhomogeneous layers is high. References: 1 Russian.

[185-2415]

## PHOTOMEMORY EFFECT IN InSb/CdTe HETEROJUNCTIONS

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 15, No 12, Dec 81  
(manuscript received 11 May 81) pp 2423-2426

VARLAMOV, I. V., V'YUKOV, L. A., KULIKOVA, O. V., MAKSIMOVA, O. G.,  
RADAUTSAN, S. I., SOLYAKOV, A. N. and FILIPP, V. I.

[Abstract] A photomemory effect has been discovered in InSb/CdTe heterojunctions, which involves a change in capacitance without significant change in current-voltage characteristic under illumination. Epitaxial CdTe films were deposited, by vacuum evaporation, on n-InSb and p-InSb substrates with  $10^{14} \text{ cm}^{-3}$  dopant concentration and [111] orientation the process ensuring that epitaxial films and substrates had the same structure. The shift of the capacitance-voltage characteristic under illumination toward either the inversion range or the InSb surface enhancement range, depending on the polarity of the applied voltage, was measured at bias voltages ranging from -1 to +1 V. A photomemory effect was recorded at temperatures from 4.2 to 150 K, of approximately the same magnitude in devices with n-InSb and p-InSb substrates. The photomemory spectrum measured at 77 K was found to have a peak near the 600 nm wavelength and a long-wave edge near 700 nm. The photomemory effect was also measured upon additional exposure of heterojunctions to 900-1300 nm radiation and found to depend on the radiation dose

as well as on the bias voltage, an additional dose generally decreasing the rate of charge storage in CdTe films. Figures 3; references 6: 5 Russian, 1 Western.  
[185-2415]

UDC 621.315.592

EFFECT OF  $\gamma$ -IRRADIATION ON PHOTOLUMINESCENCE OF GaP < Ln >

Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 15, No 12, Dec 81 (manuscript received 13 Mar 81, final version 17 Jun 81) pp 2432-2434

KASATKIN, V. A., KESAMANLY, F. P., MAKARENKO, V. G. and TSELISHCHEVA, N. S., Leningrad Polytechnic Institute imeni M. I. Kalinin

[Abstract] Stabilization of radiative recombination mechanisms in light emitting diodes, relative to quenching and recovery of luminescent properties, was studied on GaP devices with donor-acceptor pairs formed with impurities of the lanthanum series. Epitaxial 30-80 micrometer thick GaP films were deposited from a crucible with solution-melt, to which doses of lanthanides had been added, on GaP < Te > substrates with < 111 > orientation cooled from 1300 K at a rate of 1-2 K/min. The presence of lanthanides in the GaP films was monitored by chemico-spectral analysis and appearance of structureless photoluminescence bands. The specimens were irradiated with 1.6 MeV  $\gamma$ -quanta from a Co<sup>60</sup> source with a flux intensity of  $1.2 \cdot 10^{11} \text{ cm}^{-2} \cdot \text{s}^{-1}$ , for periods ranging from 2 min to 200 h. An evaluation of the stabilizing effect, in terms of slowdown of defect formation relative to that in pure GaP films at a luminescence intensity equal to half that before irradiation, reveals that europium and neodymium are most efficient (only 0.03 atom.% must be added to the melt). Here in GaP films Eu or Nd atoms are uniformly dispersed over the entire volume. For comparison, gadolinium inhibits radiative defects in silicon films only when it is present in concentrations sufficiently high for its atoms to form clusters. Tables 1; references 9: 7 Russian, 2 Western (1 in translation).  
[185-2415]

UDC 621.350.592

EFFECT OF IONIZING RADIATION ON PHOTOELECTRIC PROPERTIES OF STRUCTURES BASED ON CdTe-CdS

Baku DOKLADY AKADEMII NAUK AZERBAJDZHANSKOY SSR in Russian Vol 37, No 11, Nov 81 (manuscript received 16 Mar 81) pp 31-32

GORSHKOV, A. V., ZAITOV, F. A., ISAYEV, F. K., MIRSAGATOV, Sh. A. and RASULOV, D. T., Azerbaijan State Medical Institute imeni N. Narimonov

[Abstract] A CdTe-CdS structure is described which is subjected to neutron (pulsed and stationary) and gamma radiation. The magnitude of the dark

current, the integral and absolute sensitivity, and the lifetime of minority charge carriers are measured up to and after this action. The dependence of the photoelectric parameters on the dose (flux) is shown in a table for each type of irradiation. After irradiation the values of the dark currents practically do not change. The maximum changes of sensitivity are observed during operation in a rectifier regime. The change of the magnitudes  $S_1$  and  $S_\lambda$  are considerably smaller in a photodiode regime. In the photodiode regime a substantial increase of the region of the space charge takes place. In this case a decrease of the diffusion length does not lead to such a noticeable decrease of the magnitude of the sensitivity. During gamma irradiation a change of the sensitivity can also be caused by the surface effects in the cadmium sulfide film. The report was presented by Academician Ch. M. Dzhuvarly, AzSSR Academy of Sciences. Tables 2.  
[158-6415]

UDC 621.373.54

# ACCOUNTING FOR NONLINEARITY OF CAPACITANCES OF POWER MOS-TRANSISTOR IN LARGE-SIGNAL MODE OF OPERATION

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 24, No 11, Nov 81  
(manuscript received 8 Jul 80, after revision 24 Nov 80) pp 31-35

SAMOYLOVA, T. A.

[Abstract] A microwave MOS transistor with horizontal channel and offset gate is considered for high-speed switching in pulse circuits. Calculation of the transient process in such a power device must take into account the nonlinearity of its gate-source and gate-drain capacitances, namely their dependence on the signal amplitude. Here a simple approximation of this nonlinearity is proposed, on the basis of the dependence of gate charge on gate voltage and drain voltage, assuming that: 1) Impurity concentration is much lower in the  $n^-$ -region connected to the drain than in the p-region connected to the source; 2) That there are many more mobile charge carriers in the channel than in the depletion layer; 3) That the mobility of charge carriers is limited only by the transverse field in the gate; and 4) That the transistor has a zero threshold voltage. The intrinsic components of the two interelectrode capacitances then become linear functions of the ratio of drain voltage to gate voltage and the square root of their relative difference respectively. To these components must be added the corresponding parasitic capacitances. Averaging the interelectrode capacitances is recommended for calculation of transients in nanosecond and subnanosecond switches under linear capacitive load. Figures 3; references 7: 6 Russian, 1 Western.  
[162-2415]

## DEPENDENCE OF CUTOFF FREQUENCY OF GaAs AND InP FIELD-EFFECT TRANSISTORS ON ELECTRIC FIELD INTENSITY

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 3, Mar 82  
(manuscript received 5 Jun 80) pp 617-619

GARMATIN, A. V., KAL'FA, A. A. and TAGER, A. S.

[Abstract] The field dependence of the cutoff frequency is determined for GaAs and InP field-effect transistors with various gate lengths. Calculations, based on the temperature model of electron heating in A<sup>III</sup>B<sup>V</sup> compounds, reveal that for every gate length there is an optimum electric field intensity corresponding to maximum cutoff frequency. This optimum electric field intensity first decreases with increasing gate length, until it reaches the threshold level at which it remains as the gate becomes very long. The cutoff frequency at the optimum electric field intensity decreases with increasing gate length, being higher for GaAs devices with short gates (<0.5 micrometer) and higher for InP devices with long gates (<0.5 micrometer). Figures 4; references: 8 Western.  
[206-2415]

UDC (621.385.5:537.533).001.3

## CATHODE-RAY DIODE WITH CENTRIFUGAL-ELECTROSTATIC SHAPING OF ELECTRON BEAM

Moscow ELEKTROTEKHNIKA in Russian No 4, Apr 82  
(manuscript received 28 Jul 81) pp 39-40

PEREVODCHIKOV, V. I., doctor of technical sciences, professor, SHAPENKO, V. N., candidate of technical sciences, NAGUCHEV, O. Yu., candidate of technical sciences, LOGINOV, L. V., engineer, and YAKOVLEV, A. N., engineer, All-Union Institute of Electrical Engineering imeni V. I. Lenin

[Abstract] Fast commutation in high-voltage power supply systems of up to 1 MW rating is achieved with the aid of ELV 25/70 cathode-ray diodes, which ensure an effective recuperation of energy and thus high efficiency. The main feature of these devices is shaping of the electron beam for lossless transfer from the cathode into the field of the accelerating electrode and through the retarding field of the anode, with minimum reflection of electrons by the latter. Such an optoelectronic system has been designed with transaxial symmetry and a cylindrical cathode forming two curvilinear electron beams. It also includes two focusing electrodes, one near the cathode and one at the center, as well as an accelerating electrode and an anode. A protective electrode is added behind the accelerating electrode for reducing the current in the latter caused by secondary electron emission from the anode.

The ratio of accelerating-electrode current to cathode current and the total loss depend on the ratio of anode voltage to accelerating voltage in a manner most suitable for this particular application. Test of this device operating in the pulse mode with pulses of 1-50 microsecond duration and 1 microsecond rise time revealed no ion accumulation in the anode region and thus no variation of the current with time. Figures 3; references: 3 Russian.  
[207-2415]

UDC 621.3 97.337.222

#### SILICON ARRAY TARGETS FOR TELEVISION TRANSMITTER TUBES

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 25, No 3, Mar 82  
(manuscript received 5 Nov, 80, after completion 20 Jan 81) pp 3-11

MATYNA, L. I., MOSHKIN, V. I., PEKAREV, A. I. and CHISTYAKOV, Yu. D.

[Abstract] Silicon array targets are placed in cathode-ray tubes of television transmitters with either magnetic or electrostatic deflection. They can be variously classified according to their structural and technological features. They are either thick (unilateral, infrared) or thin (translucent substrate, membrane), with either continuous or split resistive (metallic) junction coating, with either regular or irregular mosaic, with either recombinators or separate photodiode bases. Silicon array targets are built as hybrid structures (multilayer with extra layer of wideband photoconductor material, with vacuum-tube electron-optical converter, with electron-optical modulator, with built-in integral preamplifier), as photodiode targets (planar, mesa), or with internal amplification (avalanche photodiodes, phototransistors). Most widely used are mosaics consisting of  $10^5$ - $10^6$  photodiodes with common cathode (US patent No. 3,011,089 [1958]). A review of the state of the art reveal several areas of promising further development: larger rasters for better resolution, cooling of targets for infrared operation, production of targets for commercial television sets with more than 600 lines/frame, targets with photoreceiver and preamplifier for very weak signals, electrical control of performance characteristics (spectral shift, dynamic range), improvement of vacuum-tube/solid-state and all solid-state hybrid structures. Figures 10; references 48: 12 Russian, 36 nonRussian (2 in translation).  
[258-2415]

## ELECTRON-EXCITED CONDUCTIVITY OF CHALCOGENIDE VITREOUS SEMICONDUCTOR FILMS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 3, Mar 82  
(manuscript received 30 Jan 81) pp 12-14

VLADIMIROV, F. L. and PLETNEVA, N. I.

[Abstract] A study was made of electron-excited conductivity [EEC] of chalcogenide semiconductor films  $\text{AsGeSe}_x$ ,  $x = 0.87-4.7$ , in a search for effective cathode conductors with a sufficiently high temperature softening. The longitudinal EEC, meaning the case of excitation of electron beams in which the direction of the electric field is parallel to the exciting electron beam, was studied for these glasses in a vacuum chamber with the use of an electron gun producing an electron beam with an energy of 0.2 to 15 keV, beam current density  $10^{-6}$  A/cm<sup>2</sup>. The kinetics of EEC were also studied. The variation of EEC gain as a function of primary electron energy is determined for still lower exciter beam current densities,  $10^{-8}$  A/cm<sup>2</sup>. The phenomenon of EEC was found to depend on structural specifics of the glasses, particularly the presence of ring and chain formations. The processes of EEC relaxation in vitreous chalcogenide semiconductors is quite complex and is determined by the structure of the substance, which has many types of traps and complex distribution of charge carriers through the volume of the specimen. The time constants for the glasses studied as a function of the value of  $x$  were as follows: for  $x = 4.7$ , 54 ms;  $x = 2$ , 25 ms;  $x = 0.87$  or 1.3, less than 20 ms. Figures 4; references 5: 3 Russian, 2 Western. [208-6508]

## MAGNETICS

UDC 681.846.73

### ABRASIVE-MAGNETIC TAPES FOR PROCESSING AND INSPECTING MAGNET HEADS AND TAPE WINDING MECHANISMS

Moscow TEKHNICA KINO I TELEVIDENIYA in Russian No 3, Mar 82 pp 28-30

GRIGOR'YEVA, N. G., SUROYEGINA, V. V., TERYAYEVA, I. M. and ELIASBERG, I. I.,  
All-Union Scientific Research Institute of Television and Radio Broadcasting

[Abstract] Three tapes of the combination abrasive-magnetic kind have been developed at the above Institute for processing magnet heads and inspecting their condition. The triple-layer "Zebra" tape consists of a magnetic film on a substrate covered with 3-5 micrometer thick parallel equidistant abrasive coating strips made of synthetic diamond powder (1-2 micrometer grain size) in suspension so that alternately magnetic and abrasive segments pass under the head. The double-layer tape consists of a polyether substrate carrying a film of abrasive-magnetic powder mixture in a precisely defined ratio, the optimum ratio being 85-90%  $\gamma$ -Fe<sub>2</sub>O<sub>3</sub> (grade 12) + 10-15% electrical-grade corundum powder (3/5 micrometer grain size). The magnetic properties of this tape (coercive force and remanence) as well as its abrasivity depend on the Al<sub>2</sub>O<sub>3</sub>:Fe<sub>2</sub>O<sub>3</sub> ratio. The magnetic tape with abrasive tips, for cleaning the tape winding track and the magnet head, is a magnetic tape of arbitrary length covered with abrasive film strips at the edges, produced by the same process as the triple-layer "Zebra". Figures 2; references: 2 Russian.  
[204-2415]

## MICROWAVE THEORY & TECHNIQUES

UDC 621.375.7

### PARAMETRIC MICROWAVE TRANSISTOR AMPLIFIER

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY; RADIOELEKTRONIKA in Russian  
Vol 24, No 11, Nov 81  
(manuscript received 12 May 80, after revision 11 Nov 80) pp 73-74

BAZARNITSKIY, Yu. B. f GANZIY, D. D. and MALYSHEV, V. A.

[Abstract] A parametric microwave amplifier has been built using a 2T371A transistor commercially produced in the Soviet Union. It includes low-pass filters, two for useful signal and one for pumping signal, inductance coils for tuning and matching, chokes for power supply isolation, separating capacitors and blocking capacitors. It was tested with a 4 GHz input signal and 5 mW - 8 GHz pumping. It has a sharp resonance peak, its noise factor depends on the resistance of the signal source, its transfer ratio depends on the collector-base voltage, and its gain in the passband varies with pumping power from 3 to 25 dB. Its advantage over a parametric diode amplifier is much simpler construction and longer life. Its advantage over plain transistor amplifiers is much higher gain with approximately the same noise factor. Figures 2; references 3; 1 Russian, 2 Western.  
[162-2415]

UDC 621.372.8.049.75;681.3.06

### MICROWAVE COMPONENTS AND DEVICES BASED ON COUPLED MULTICONDUCTOR MICROSTRIPLINES

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY; RADIOELEKTRONIKA in Russian  
Vol 25, No 3, Mar 82  
(manuscript received 29 Oct 80, after revision 8 May 81) pp 60-63

KARPUKOV, L. M.

[Abstract] The scattering matrix of a segment of  $n$  coupled multiconductor microstriplines is derived from the corresponding telegraph equations and

their determinant, assuming their particular solutions to be simple exponential functions based on sinusoidal voltages and currents. Calculation of the matrix coefficients has been programmed in FORTRAN for YeS "Unified System" computers, suitably for analysis of microwave components and devices operating with quasi-TEM modes. Figures 2; references 4: 2 Russian, 2 Western (1 in translation).

[258-2415]

UDC 621.372.85.001.24

#### IMPEDANCE CHARACTERISTICS OF SLOT MOUNTING STRUCTURE FOR LUMPED ELEMENT IN WAVEGUIDE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 26, No 12, Dec 81  
(manuscript received 5 Jun 79, after revision 22 Apr 81) pp 2517-2523

KARTSEV, Yu. A. and YELISEYEV, N. I.

[Abstract] The results of theoretical and experimental investigations of a bar mounting structure are shown in a 1972 report from the literature. The bar is an inductive cylindrical bar in a gap of which a lumped element is mounted (dielectric specimen, semiconductor diode and the like). Equivalent circuits and expressions are obtained by the electrodynamic method. These determine the impedance of the mounting structure, reduced to the terminals of the element. In spite of a number of assumptions in the formulation of the problem, the results of theoretical analysis agree well with the results of experiment. In the present work using the same assumptions as in the 1972 report, the nature is found of the equivalent circuit and the impedance characteristics of the slot mounting structure--capacitive diaphragm with a lumped element mounted in it. A figure shows a plane-transverse joint of waveguides 1 and 2, different in height. A slot mounting structure for a lumped element of zero thickness is placed in the joint. It is shown that the equivalent circuits and expressions which determine the impedance (admittance) characteristics of an infinitesimally small slot mounting structure in a plane-transverse joint of two rectangular waveguides of different heights are correct for a wide frequency range. This includes the frequencies at which the waveguides are multimode. In the case of a thick mounting structure located in a regular single-mode wave guide, known solutions for an empty capacitive diaphragm of finite thickness are used to make more accurate the equivalent circuit and calculated relationship. The results obtained in this work can be utilized in particular for determining the properties of a slot mounting structure which is of importance from the point of view of creating equipment based on semiconductor devices such as regenerators and frequency multipliers. The authors thank Ya. N. Fel'd for helpful discussion of the results of the work. Figures 7; references 7: 4 Russian, 3 Western (1 in translation).

[152-6415]

# MATHEMATICAL MODELS FOR ENGINEERING ANALYSIS OF WAVEGUIDE-DIELECTRIC SLAB STRUCTURES

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 25, No 3, Mar 82

(manuscript received 30 Oct 80, after revision 20 Apr 81) pp 58-60

POKROVSKIY, Yu. A. and AFROMEYEV, V. I.

[Abstract] Mathematical models are developed for analysis of the basic element in waveguide-dielectric structures with slabs perpendicular to the waveguide axis, namely a supercritical resonator with such a slab. For illustration, the algorithm of generating a model is applied to a five-layer structure and its equivalent circuit, the basic model being that of a three-layer device. Recurrence relations are obtained for transmission and reflection coefficients in a cascade, with a fictitious gain related to crosstalk attenuation introduced as a generalizing parameter. An expression is also obtained on this basis for the Q-factor of the coupling in multicavity resonators. Results of model calculations are compared with experimental data. Figures 2; tables 1; references: 8 Russian.  
[258-2415]

# MULTILAYER MICROSTRUCTURES WITH ZnO FILMS FOR SURFACE-ACOUSTIC-WAVE DEVICES

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 24, No 11, Nov 81

(manuscript received 4 Jun 80, after revision 31 Mar 81) pp 70-73

GRANKIN, I. M., LOPUSHENKO, V. K. and POGREBNIYAK, V. P.

[Abstract] The technology of depositing highly directional fine-disperse ZnO films on fused quartz and thermally stable S79-2 glass substrates is viewed from the standpoint of producing SAW devices with interdigital structure, the main object being to ensure excellent piezoelectric properties of such films with or without metal coating. In an experimental study such films were produced by ion-plasma deposition in a d.c. triode system in Ar + O<sub>2</sub> atmosphere. Optimum process conditions were found to be a deposition rate of 0.2-0.3 nm/s under pressure of  $6.66 \cdot 10^{-2}$  Pa, with substrates in an aluminum container heated to 450-500 K and 100 mm away from a cooled target made of 99.9% pure ZnO powder. Such ZnO films were incorporated in band filters with interdigital structure formed in aluminum film on vanadium sub-layer by the photolithographic process and in this configuration tested for acoustic properties. The electromechanical coupling coefficient, phase

velocity, propagation loss and insertion loss were measured on specimens with 20 pairs of digits each but with different grating periods (80, 40, 24, 17 micrometer), and a distance between digits equal to 125 wavelengths and aperture (overlap of digits) equal to 70 wavelengths, with or without shorting electrode. Insertion losses were found to be smaller without than with shorting electrode (metal coating) in structures with thickness-to-wavelength ratio  $h/\lambda \geq 0.1$  and minimum (down to 9 dB) in structures with  $h/\lambda \geq 0.4$  in the matching mode (typical thickness of ZnO film  $h = 3 \mu\text{m}$ ). Propagation losses were found to be low and fairly constant in structures on quartz substrates, much higher and frequency dependent in structures on glass substrates so that the latter are not advisable for frequencies above 100 MHz. The amplitude-frequency characteristics were also measured, and found to agree closely with theoretical ones. Figures 5; references: 3 Western.  
[162-2415]

POWER ENGINEERING

UDC 621.3.066.3:537.3.12.62

UTILIZATION INDEX FOR SUPERCONDUCTING MATERIALS IN SWITCHING ELEMENTS OF POWER CIRCUIT BREAKERS

Kiev TEKHNIЧЕСКАЯ ELEKTRODINAMIKA in Russian No 2, Mar-Apr 82  
(manuscript received 4 Nov 80) pp 10-15

BARANOV, G. L. and MARKOVSKIY, N. V., Institute of Electrodynamics,  
UkSSR Academy of Sciences, Kiev

[Abstract] A utilization index for superconducting materials in switching equipment is defined as the ratio of material volume to nominal interrupted power, both quantities referred to their respective values for a tentatively standard layer of such material. With this index as criterion, four design variants of a superconductor switching element for a power circuit breaker are evaluated comparatively on the basis of known geometrical, physical and circuit relations. The simplest design is a helical or stacked bifilar double layer, the next design is a stack of M layers electrically in parallel. There follows a variant featuring L groups of M electrically parallel layers in series and a variant featuring two groups in series with K layers in the first and K + 1 layers in the second. Figures 2; references 11: 9 Russian, 2 Western.  
[257-2415]

UDC 621.311.076.12.026.5

CONTEMPORARY STATUS AND PROSPECTS FOR DEVELOPMENT OF STATIC REACTIVE POWER COMPENSATORS

Moscow ELEKTRICHESTVO in Russian No 8, Aug 81  
(manuscript received 1 Dec 80) pp 6-11

VENIKOV, V. A., doctor of technical sciences, KARTASHEV, I. I.,  
FEDCHENKO, V. G., candidates of technical sciences, MAKAROVA, T. P.,  
YEDEMSKIY, S. N., POLEVAYA, V. P. and CHEKHOV, V. I., engineers, Moscow  
Power Engineering Institute

[Abstract] A survey made of the directions and results of an investigation of foreign static components of reactive power is concerned with the

following: 1) Test of operation of static compensators in electrical systems; 2) Possible areas of use of static compensators of reactive power; and 3) Analysis of existing types of static sources of reactive power. It is concluded that the use of static compensators leads to a considerable improvement of the indices of electrical systems in both static and dynamic regimes. This is confirmed not only by computation data and experiments on physical models, but also by operating experiences of devices in real systems. Figures 9; references: 1 Western.  
[87-6415]

UDC 621.313.32:537.212

#### OPTIMIZED DESIGN PROCEDURE FOR POLE SHOE OF ELECTRICAL MACHINE

Moscow ELEKTROTEKHNIKA in Russian No 4, Apr 82  
(manuscript received 23 Feb 80) pp 17-19

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YURGENSON, T. S., candidate of technical sciences, Moscow Institute of  
Power Engineering

[Abstract] A study was made in order to determine the effect of changes in size and shape of pole shoes on the harmonic content in the permeance distribution around the air gap of an electrical machine, taking into account technological factors and assuming a low saturation level ( $k \approx 1.2$ ) in the steel. The three parameters varied were: relative pole width, ratio of maximum gap at the edge to minimum gap at the center, and ratio of minimum gap to pole pitch. Calculations were made for an infinite number of poles, i.e., a straightened stator bore using the method of Fourier analysis on a Minsk-32 computer. The data, tabulated and in the form of graphs, indicate the best combination of geometrical parameters to be selected already in the first stage of design for a most nearly sinusoidal field distribution. The results of this study were used for design of low-vibration synchronous generators with ratings up to 100 kW at 380 V and 400 Hz. Subsequent tests have proved the effectiveness of this design procedure. Figures 3; tables 1; references: 4 Russian.  
[007-2415]

## IMPROVING FORCE CHARACTERISTICS OF MAGNETIC SUSPENSION IN MAIN FIELD OF INDUCTION MOTORS

Moscow ELEKTROTEKHNIKA in Russian No 4, Apr 82  
(manuscript received 5 Aug 81) pp 13-14

GALKIN, V. I., candidate of technical sciences, and YUDIN, Yu. B., engineer, Iovniem (expansion unknown)

[Abstract] Magnetic suspension is used instead of solid bearings in induction motors which operate in aggressive media eliminates mechanical contacts between the rotor and stator. The centering force of such a magnetic-resonance bearing, used in small and miniature devices with light-weight rotors, depends on the operating conditions. It is inherently small at start and large slips, which requires reduced-load starting or prolonged low-speed operation on standby ball bearings during faults. The problem can be largely eliminated with a compound rotor, somewhat larger in size, one part a conventional squirrel cage and one a stack of electrical-grade steel laminations without a winding. The magnetic pull and the centering force are calculated here on the basis of the equivalent circuit in terms of motor (stator and rotor) reactances and resistances, voltage, frequency, and nominal air gap. The design parameters of such a rotor are established from these relations. Its theoretical force characteristic is compared with experimental data on a rotor with a  $K = 1/3$  ratio of copperless to total rotor surface area. Figures 2; references 4: 3 Russian, 1 Western.  
[207-2415]

## FIRST MACHINE TESTED: TURBOGENERATOR WITH SUPERCONDUCTING COILS

Moscow KHIMIYA I ZHIZN' in Russian No 12, Dec 81 pp 4-7

GLEBOV, I. A., academician

[Abstract] A high-power turbogenerator with superconducting field coils has been developed at the All-Union Scientific Research Institute of Electrical Machine Design. The rating of this KTG-20 machine is 20 MVA - 6300 V - 3000 rpm. Its rotor is a rotating helium cryostat with thermal and electromagnetic shielding, also with two vacuum layers for thermal insulation. The rectangular  $2.5 \times 3.5 \text{ mm}^2$  field conductors in the rotor each consist of a copper matrix with 3600 strands of  $\text{Cu} + 50\% \text{Ti}$  alloy filling 37% of the cross section. The critical current is 2200 A and, in a magnetic field of 5 T, the superconducting transition temperature is 10 K. Other distinguishing features of this machine are a toothless stator construction and Freon cooling of the armature coils. This provides more space for copper on the inside surface of the ferromagnetic core, the latter also serving as external electromagnetic shield. The advantages are smaller outside diameter, heavier electric loading, and noiseless operation. The armature conductors in the stator

are made of thin Litz-wire strands 0.57 mm in diameter, intrically twisted for complete suppression of circulating currents in phase coils. Impregnation with epoxy compound facilitates heat conduction from conductors to Freon cooling ducts. The turbogenerator is started by cooling the rotor first from room temperature (290 K) to 150 K with gaseous helium which had been precooled in a liquid-nitrogen heat exchanger, then to 80 K by injection of liquid helium into the gas, and finally to the superconducting transition temperature with liquid helium alone. The first experimental-production unit built and tested has record low eddy-current losses, only 7% of all electrical losses in the machine. This machine is the prototype of larger ones to come, first a 300 MW one and then eventually 800, 1000, 2000 and 3000 MW ones for thermal electric and atomic electric power plants of the future. Figures 3; references: 1 Russian.  
[161-2415]

UDC 535.42:534.2

DIFFRACTION OF LIGHT BY SURFACE ACOUSTIC WAVES IN ISOTROPIC MEDIUM

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 3, Mar 82  
(manuscript received 21 Jan 80, after correction 25 Mar 81) pp 421-424

BALAKSHIY, V. I., PARYGIN, V. N. and TANKOVSKI, N. S.

[Abstract] The problem of diffraction of light by surface acoustic waves in an isotropic medium is treated by resolution of the light wave after diffraction into a sum of plane waves. The theoretical solution is more complete and accurate than those obtained in the phase-grating approximation or by the perturbation method. Diffraction of light by a surface acoustic wave can now be analyzed over the entire range of incidence angle and including the additional diffraction which occurs as light continues to travel through the surface deformed by the acoustic wave. The results can be extended to anisotropic media. Figures 1; references 4: 3 Russian, 1 Western.  
[206-2415]

UDC: 535.312

ANALYSIS OF PHOTOMETRIC PROPERTIES OF OBJECTS WITH REVERSE REFLECTION

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 3, Mar 82  
(manuscript received 13 Oct 80) pp 7-10

KHOLOPOV, G. K.

[Abstract] In the case of reflection of light from an object back toward the source of the light, the use of the adjusted dimensional brightness factor allows simple expression of the luminance at the input of the receiving system. Conditions of illumination of an object and reception of the light reflected from it are analyzed, assuming a point source of radiation. It is found that the close zone in which the adjusted dimensional brightness factor varies as a function of distance depends both on body shape and body orientation, as well as the reflective index of the body

surface. The close zone may increase without limit for bodies with mirror reflecting surfaces consisting of flat elements or elements with flat generatrices such as cylinders and cones. When studying the reflecting properties of distant objects it must be considered that the luminance created at the input aperture of the receiving system by diffuse systems of the model is proportional to the square of linear scale, while that created by reflecting sections is proportional to scale to a power which may be less than 2 (0 for a mirror disk, 1 for an infinitely distant mirror cylinder, 2 for a mirror sphere). Figures 4; references: 5 Russian.  
[208-6508]

UDC: 621.383.814

TWO-FREQUENCY MODULATION WITH QUARTER PERIOD SHIFT AS METHOD OF  
DETERMINING PULSE GENERATION LOCATION OF PHOTOMULTIPLIER

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST' in Russian No 3, Mar 82  
(manuscript received 1 Sep 80) pp 3-6

SOROKIN, O. M.

[Abstract] A number of special studies involving simultaneous illumination of several electrodes require precise determination of the partial gain or secondary electron emission coefficients of each stage in a photomultiplier. The author has developed a measurement circuit allowing rapid determination of the individual contribution of any given electrode to the total noise or photocurrent of a photomultiplier. This article analyzes the operating principle of the method, in which the photocathode is illuminated by meander radiation at 500 Hz at a level so weak that only single-electron pulses are produced at the output of the photomultiplier. Scanning of the amplitude spectrum at twice the input frequency allows recording of the contribution of pulses from any photomultiplier electrode, as well as the influence of radiation which passes through the photocathode in its transparent areas and excited other electrodes. If certain assumptions are made, the contribution of electrons which miss the dynodes can also be determined. Figures 4; references: 4 Russian.  
[208-6508]

BASIC CHARACTERISTICS OF PIEZOELECTRIC INFRARED-RADIATION RECEIVER

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 3, Mar 82  
(manuscript received 16 Nov 78, after correction 14 May 80) pp 525-528

SMAGIN, A. G., GUSHCHIN, M. N. and MIL'SHTEYN, B. G.

[Abstract] The performance characteristics of a piezoelectric infrared-radiation receiver are calculated theoretically from the differential equation of heat conduction for a plane-parallel plate with boundary conditions of the third kind. The results are compared with the actual characteristics of quartz-crystal devices. Their time constant is almost the same, but their threshold sensitivity is much lower. In the measurements were included the temperature coefficient of oscillation frequency, thermal noise and variations of the difference frequency it causes as well as the temperature difference between active cell and compensating cell in the receiver head. Figures 1; references: 3 Russian.  
[206-2415]

UDC 535.13

## DEFLECTION OF LIGHT BY MEANS OF SPACE-TIME MODULATOR WITH ELECTRON ADDRESSING

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 3, Mar 82  
(manuscript received 21 Jan 81) pp 529-533

MANKEVICH, S. K., NAGAYEV, A. I., PARYGIN, V. N., PASHIN, S. Yu.,  
STAVRAKOV, G. N. and KHORKIN, S. V.

[Abstract] The feasibility of deflecting a light beam through a given angle by means of an optoelectric crystal (deuterium-potassium phosphate) acting as a space-time modulator is examined on the basis of theoretical considerations and experimental results. Deflection of a light wave requires a phase shift linearly increasing in a certain direction. This can be achieved by impressing a voltage which increases linearly in the same direction on the surface of such a crystal. Larger deflection angles are possible with a sawtooth voltage rising to an amplitude which corresponds to a  $2\pi$  phase shift. The potential relief can be recorded on the crystal surface with an electron beam and charge-to-voltage conversion. Calculations for this have been made by a numerical method with the aid of inverse Fourier transformation. In the experiment a light beam from a coherent source passed through a collimator to a rotating cube, from here in one direction through a  $45^\circ$ -polarizer and the  $KD_2PO_4$  modulator crystal on a fluorite substrate with a Peltier micro-cooler around to a mirror, then returning after reflection through the crystal, polarizer, and cube to a Fourier-transforming lens. The diffraction pattern formed in the focal plane of this lens was magnified by an objective lens and then focused on the photocathode plane of a photomultiplier. The electron beam for treating the crystal surface was generated in an electron gun with a 15 kV accelerating voltage, in the nonequilibrium mode, and its current was modulated by a sawtooth voltage generator. It was possible in this way to deflect the light beam through an angle of  $1.6 \cdot 10^{-4}$  rad without the losses exceeding 20%. The angular resolution of this deflector with a  $16 \times 16 \times 0.22$  mm<sup>3</sup> crystal, determined by aberrations caused by the modulator and by diffractive divergence of the light, was found to be  $(3.7 \pm 0.3) \cdot 10^{-5}$  rad according to the Rayleigh criterion. Figures 4; tables 1; references: 2 Russian.  
[206-2415]

## CURRENT FLOW THROUGH SUBMICRON SEMICONDUCTOR LAYERS IN QUASI-BALLISTIC REGIME

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 26, No 12, Dec 81  
(manuscript received 7 Jan 81) pp 2635-2642

BANNOV, N. A., LEYMAN, V. G. and RYZHIY, V. I.

[Abstract] A study is made of the special features of the current flow through a thin semiconductor under the condition of an intense nonuniformity of electron gas when the movement of electrons has a quasi-ballistic nature. During this the stationary characteristics are considered and basic attention is given to two layers of factors, specific for semiconductor layers. These are: the presence of stationary charged centers (e.g., donor) and relatively infrequent acts of scattering of electrons. Quasi-ballistic regimes of current flow can be basic for devices of submicron dimensions. Use of just such regimes assists in a broadening of the possibilities of these devices with use of them, for example, as elements of digital technique. The authors thank R. A. Suris, V. A. Fedirko and V. A. Gergel' for discussion and helpful comments. Figures 6; references 7: 5 Russian, 2 Western.  
[152-6415]

## TRANSPORTATION

UDC 531.767.087.92:620.1

### ANALOG DEVICE FOR MEASURING LINEAR VELOCITY IN TEST STANDS

Moscow IZMERITEL'NAYA TEKHNIKA in Russian No 4, Apr 82 pp 15-17

PETLENKO, B. I., TOPIL'SKIY, V. A. and NAUMENKO, B. Yu.

[Abstract] A device has been developed for measuring the linear velocity of automobiles in a test stand by the analog method. It is mounted on the same metal guide rails on which the wheels of the tested vehicle run. It consists of a high-frequency oscillator, an amplifier, a detector, a filter and a differentiator. The a.c. voltage is applied across a segment of one rail, the grounded one, along which wheels of the vehicle will run. Across the matching segment of the other rail will appear an AM signal whose envelope corresponds to the distance traveled. The derivative of this envelope is proportional to the wheel velocity. The static error can be minimized by using a high carrier frequency, whose lower limit is determined by the spectral density of the input signal and which imposes stringent requirements on the design parameters of the measuring system components. The dynamic error is determined mainly by nonideality of the differentiator stage. This error can be minimized by matching the time constant of the transformer primary with the vehicle mass, final velocity and acceleration time. According to experimental data, the total relative error of the device operating with a carrier frequency of 1000-5000 Hz and a rail current of 1.4 A is within 5-7% at an acceleration of  $30 \text{ m/s}^2$ . Figures 2; references: 5 Russian, [259-2415]

NEW ACTIVITIES, MISCELLANEOUS

UDC 538.56.001.24

SYNTHESIS OF EIKONAL OF GIVEN STRUCTURE BY IMPLEMENTATION OF DEFINITE  
LAW FOR VARIATIONS IN MEDIUM CHARACTERISTICS

Moscow ELEKTRICHESTVO in Russian No 8, Aug 81  
(manuscript received 6 May 80) pp 52-54

GRACH, I. M. and URSEITOV, O. U., Frunze Polytechnical Institute

[Abstract] In geometrical optics with superhigh frequencies the necessity often arises for creation of an eikonal of a given structure, which makes it possible to direct a family of rays into the proper direction. In order to solve such problems it is advisable to direct a family of rays into the proper direction, and to employ the curvilinear orthogonal system of coordinates called the natural coordinates of electromagnetic fields. Earlier such coordinates were used in a 1980 paper by I. M. Grach (see above) for calculation of potential fields. Use of these coordinates makes it possible to find the law of change of the characteristics of the medium. This realizes a given movement of the family of rays. Two examples are given of such realization: 1) Inside some convergent right cone; and 2) Inside an unparted hyperboloid. Figures 2; references: 3 Russian. [87-6415]

UDC 621.372.632.029.6

RELATIVISTIC DOPPLER-TYPE FREQUENCY MULTIPLIER OPERATING AT CYCLOTRON  
RESONANCE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 27, No 3, Mar 82  
(manuscript received 28 Aug 81) pp 578-582

ALEKSANDROV, A. F., GALUZO, S. Yu., KANAVETS, B. I., KUBAREV, V. A.,  
PLETYUSHKIN, V. A., SOKOLOV, S. A. and CHEREPENIN, V. A.

[Abstract] A relativistic Doppler-type frequency multiplier is described which consists of three segments: a high-power O-type Cerenkov generator-prebuncher, a waveguide where cyclotron oscillation builds up parametrically

in a periodically nonuniform magnetic field, and an electronic synchrotron maser. The operation of this device is based on resonant scattering of electromagnetic waves by helical electron beams. In an experiment performed in the "Tandem-1" test stand a 0.5 MeV, 3-5 kA electron flux was emitted by a thin annular cathode 50 mm in diameter. The 240 mm long prebuncher consisting of rings with a 3 mm radius of curvature and an electrodynamic system with a period of 14 mm generated electron beam pulses 1-2 mm thick of 80-100 ns duration. The waveguide diameter was 56 mm, the magnet system here made of soft iron. The pulse power of coherent millimeter-wave radiation was measured as a function of the induction of the focusing magnetic field and found to peak sharply to almost 50 MW at approximately 10 kG. Measurements were also made without prebunching and the power found to be one order of magnitude lower, but subsequent optimization of the waveguide design restored it to 15-50 MW. Figures 2; references 10: 9 Russian, 1 Western.  
[206-2415]

CSO: 1860

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